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the Petroleum Engineer

FOR MANAGEMENT

SEPTEMBER 1958

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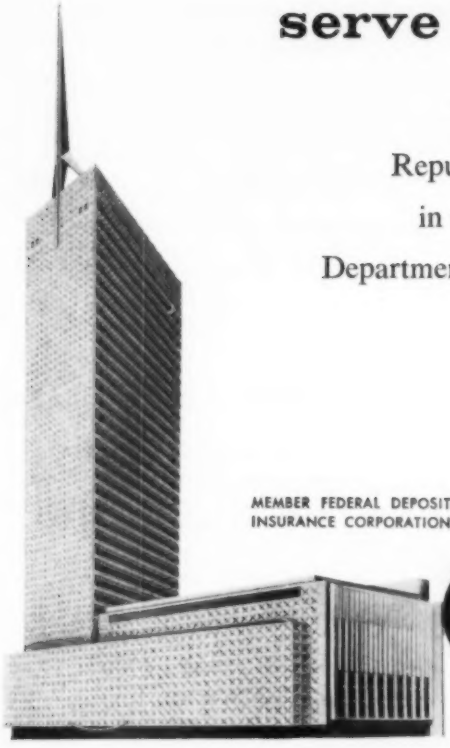

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the Petroleum Engineer

FOR MANAGEMENT

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The Unreliable Genie of the Middle East

OUR PETROLEUM PRIMA DONNA has gone on another temperamental binge. But the audience has to admit that nobody — just nobody — except the Middle East can get away with it.

Whatever the august governments of the world say — they are all thinking of the superb talents of the veiled beauty — namely, some 100 or 300 billion barrels of liquid gold.

The trouble with the Middle East has been laid to family squabbles, inferiority inhibitions, nationalist ambitions, Zionist proximity, Soviet wooing.

The trouble with the Middle East is the genie that never was bottled up. In legendary days the hero wished for gold and gems and — presto — he got them. In modern times the wish for wealth was granted almost before it was made. There was no sweat nor work nor sacrifice. No night lamps burned, no plow was sharpened, no boss' daughter had to be married. Where in ancient times manna fell from heaven, now money flows from the desert floor.

These rich nations in the Middle East are indebted only to a genie of geology. Recently in Iraq's Third Annual Development Week, King Faisal II dedicated more than $800 million in national projects either built or building: A textile factory, a sugar factory, a cement factory; highways and bridges, water and power stations; agricultural projects; housing schemes.

Shortly after presenting these modern gifts to his country the King was shot down. What, you might well ask, do the people want?

Well, let's face it, ruling Iraq is one of the world's best paying jobs and that encourages competition. But that isn't the whole answer. We believe the confusion in the Middle East is stirred more by the people's philosophy of genie economics than by political intrigue and social backwardness. The genie scheme of things is not to work for what you want — you look for a lamp you can rub.

IN ANOTHER DECADE the petroleum industry will make great inroads on this blanketing inertia. Amazing advances have already been made. Ten years ago a man would join an oil company until he had some money in his pocket then he'd quit. In 1955 Aramco's annual turnover was reduced to 12 percent, an indication of progress.

Foreign oil firms have also helped individuals to set up their own businesses and then purchase services and products from them. When more of the Mideast people learn the wisdom of work, there will be less time for the exciting game of plot and counterplot.

An economic system where a person can earn, save, invest and spend for himself and his family, will run more efficiently than anything bottled genies ever unleashed — whether it is sudden gold in a varient Middle East or sudden power in the locked spaces of old Russia.

Oil companies in the Middle East have marked the road for a modern economy and hastened the time when Mideast people will realize that the most satisfying riches for the individual is to have a job and the ability to fill it. When that comes to pass, political and material problems will settle down to normal confusion.

Ernestine Adams

Joe Roughneck, heart of the oil and gas industry, likes the convenience and economy of having Lone Star's ultra-modern pipe mill right in the middle of his workshop. Lone Star maintains the largest mill stock of API casing and tubing in the entire oil country. Delivery can be made overnight to 75 per cent of the active areas. Lone Star's recently enlarged plant is, more than ever, Joe Roughneck's solid source of supply.

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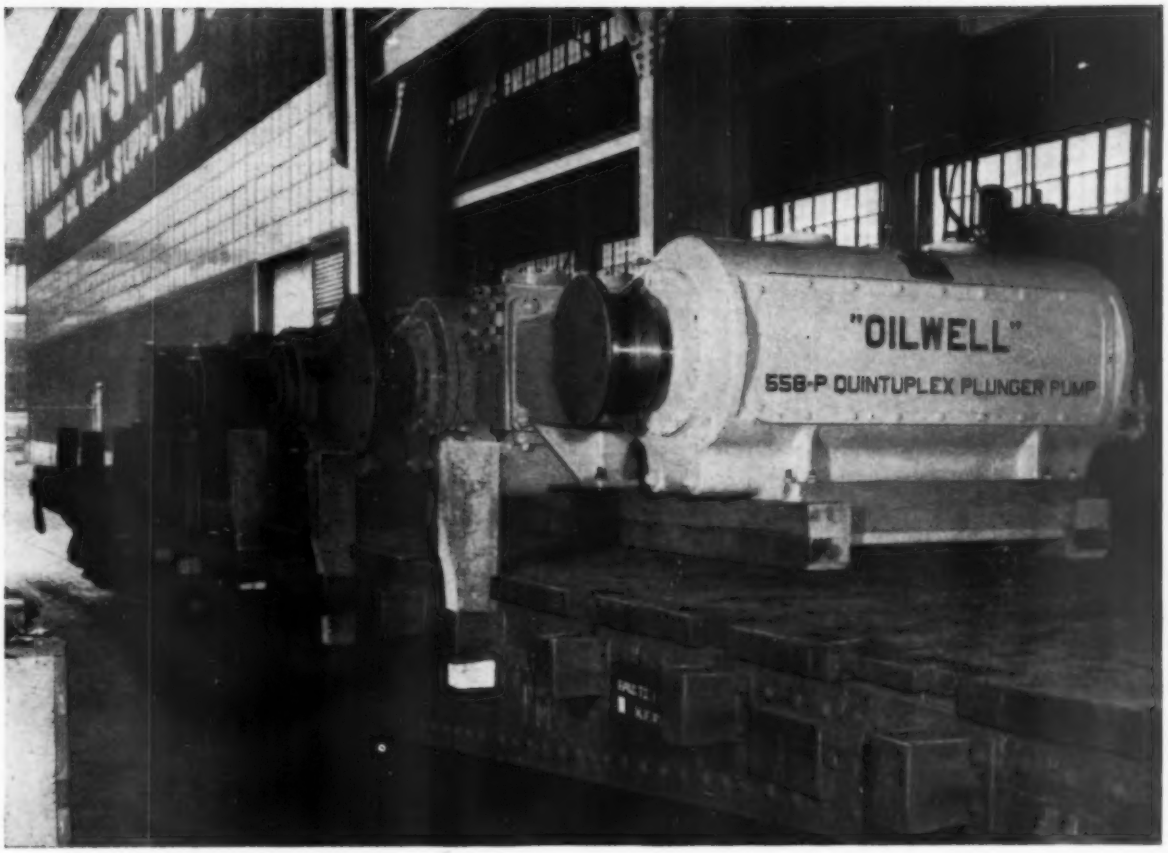

Enroute to Long Beach, California for the World's Largest Waterflood

This is the first group of four, from an order of twelve, "Oilwell" 558-P Quintuplex Pumps which will inject sea water into the oil sands of the Wilmington field in the Long Beach Harbor area. When complete, operators expect this to be the largest waterflood project to date.

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Petroleum Profile

WHEN the spotlight began to shine with increasing brightness on E. Clyde McGraw, Transco's then vice president for operations had already organized and had been directing for five years a team with a name for consistently operating a natural gas pipeline at nearer its theoretical maximum capacity than had been achieved by other major lines.

By the end of 1955—the year he became executive vice president—daily allocations of Transcontinental Gas Pipe Line Corporation had climbed from nothing, six years before, to 705.5 million cubic feet plus winter peaking gas from storage of 136.4. That year Mr. McGraw had supervised construction of $72 million worth of new facilities as the gross plant investment grew to $345 million.

In mid-1956 he was elected to membership on the board. During that year Transco constructed $36 million of new facilities.

In the spring of 1957, he became president and chief executive officer. Under his continued guidance, the gross investment in pipelines and related facilities last year increased by nearly $100 million of new construction to a total $479 million. Daily allocations climbed to 948 million cubic feet which, supplemented on peak days from storage, brought the total peak-day allocation to more than one billion cubic feet.

On President McGraw's desk today are blueprints for new construction to cost in excess of $167 million, for connections with extensive offshore gas reserves, for new storage facilities near the New York market, for mainline loops and compressor stations, for increased throughput, for stepping up gas transportation service.

E. CLYDE McGRAW

President

Transcontinental Gas Pipe Line Corporation

WHAT QUALITIES guided this Nebraska farm boy in his steady march to the Transco presidency?

First, he is a calm man with an inherent equilibrium. His personal magnetism and the confidence he inspires as a leader creates in those who work with him a genuine enthusiasm.

To his board of directors he has exhibited through the years an ability to weigh multiple factors and make policy decisions which prove out. He possesses the talent of overall perspective so necessary to successful management of a business so diverse as natural gas transmission.

E. Clyde McGraw was born in 1903 on a farm near Elwood, Nebraska. To pay his way through the University of Nebraska, he sold vacuum cleaners, wound electric motors, and strung power lines. At the age of 23 he was awarded a degree in electrical engineering.

Swift years that followed gave him wide experience and developed his trait of continuous learning. He was successively junior engineer, engineer, local superintendent and district superintendent for Western Public Service Company. In 1937 he went to the Texas-New Mexico Utilities as general superintendent. In 1941 he joined the operating division of Stone & Webster and later became vice president. During the 1945-49 period he also served as president of Montaup Electric and vice president of Haverhill Gas Light, Fall River Gas Works, and Tampa Electric companies.

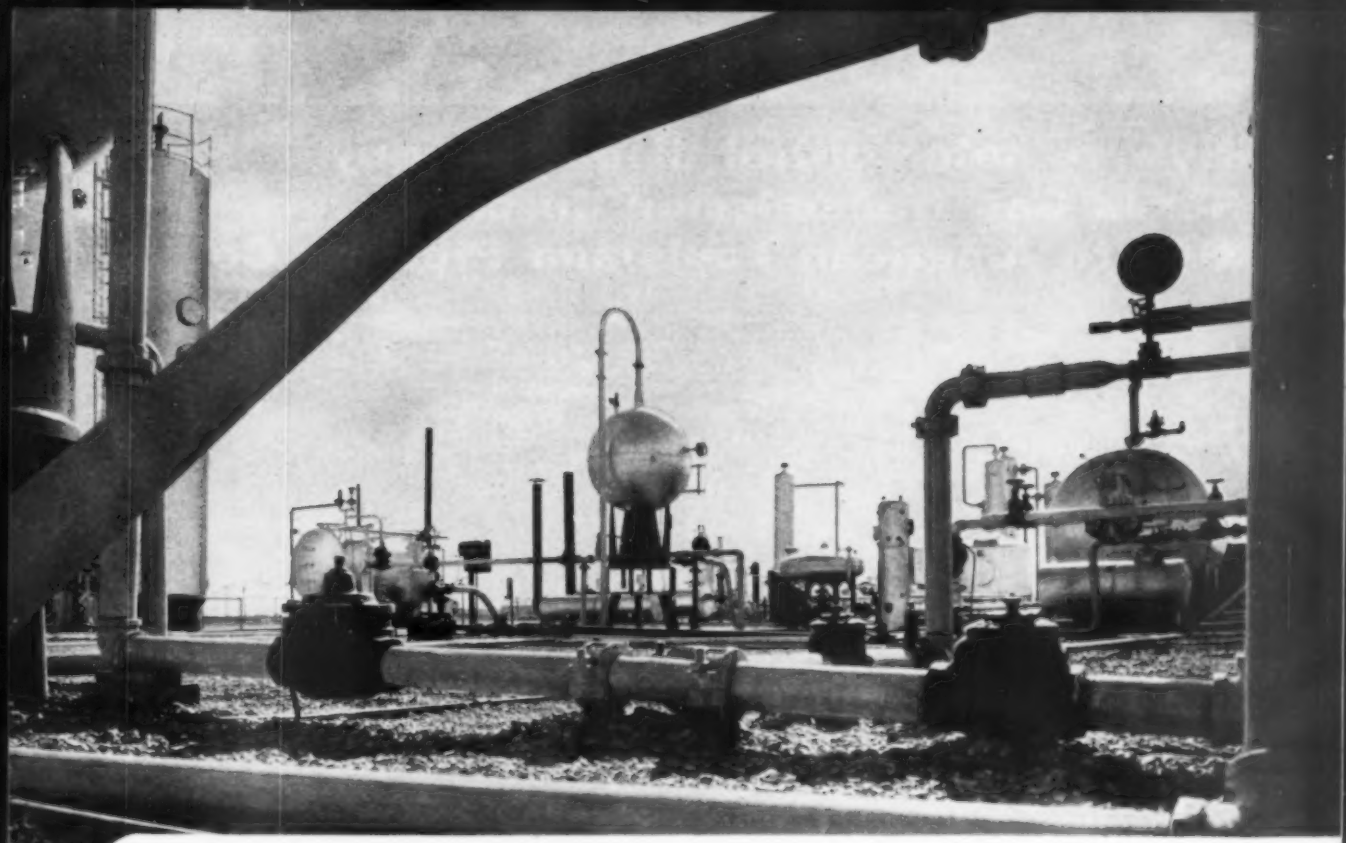
His work as a Stone & Webster New York vice president led to Transco. His assignment was that of adviser to gas companies. When construction began on the longest pipeline ever planned, Mr. McGraw came as adviser to the fledgling company which was then building a $200 million pipeline from Texas to New York City. As the pipeline inched across the Deep South and up the Eastern Seaboard, Mr. McGraw became more and more attached to this big engineering project. What is more, he was immensely intrigued by the challenge of operating the longest pipeline ever built.

In July 1950, he accepted when the Transco Board offered him the position of vice president for operations. He rapidly began pulling together the operating organization that today continues as a team. On January 16, 1951, at the point on Manhattan where 134th Street meets the Hudson River, a valve was turned and natural gas from Texas reached New York City for the first time.

MR. McGRAW had come to Transco as an adviser from Stone & Webster. He had remained to be part of the company and to build and head an operational organization. His managerial talents were and are such that he became president.

He is a member of the boards of directors of Southern Gas Association, Texas Manufacturers Association, Bank of the Southwest, Houston Chamber of Commerce, United Fund of Houston and Harris County, Junior Achievement of Houston, Inc., and a member of a number of gas industry and professional associations.

He plays golf infrequently. Occasionally he takes a turn at deep-sea fishing. His favorite sport is hunting in the mountains and north woods. Not too long ago he realized a life-time ambition by bagging a moose.



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Out of these BS&B facilities for product research and development ... and out of the minds of the men who labor here ... have come notable technological advancements in natural gas and crude oil production, processing, measurement and storage.

These facilities, staffed by highly experienced, full time development engineers, provide for full-scale testing of equipment under actual lease conditions. The laboratory has an oil, water and gas circuit which allows testing of low pressure equipment at oil flow rates up to 3,500 barrels per day, and a high pressure gas circuit, capable of flowing 10 million standard cubic feet of natural gas per day.

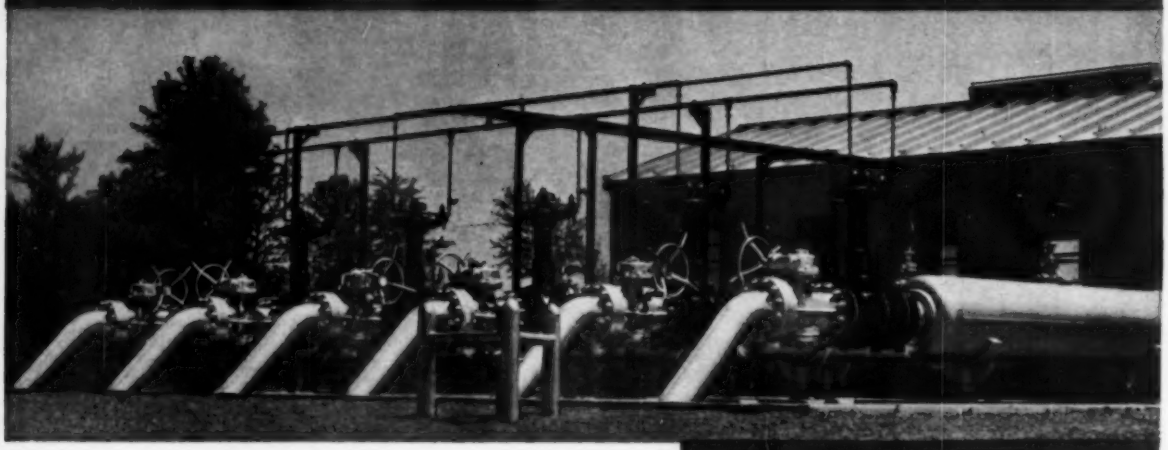
Examples of new equipment developed and tested here include BS&B's Lease Automation Systems, Liquid Metering Equipment and Ammonia Absorption Refrigeration Units. These contributions to a better future for the oil and gas industries were made possible by *you*, our customers, because a part of every dollar invested in the purchase of BS&B oilfield equipment goes into a continuation of this research and development program.

From it you will receive many future "dividends" in the form of new equipment developments, improved technology and additional savings through increased operating economy. Make it a habit *always* to call your BS&B man *first!*

"BS&B research shows the way"

BLACK, SIVALLS & BRYSON, INC.
Oilfield Equipment Division, Dept. 1-C9
P.O. Box 1714 Oklahoma City, Okla.

How remote control dispatching by Texas Gas Transmission Corp. delivers GAS to American Louisiana Pipeline Co.



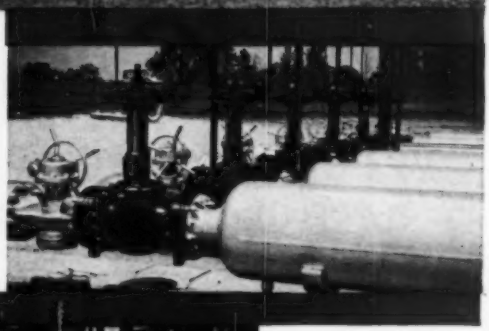
At Texas Gas Transmission Corporation's measurement station near Slaughters, Kentucky, need for attending personnel is eliminated by use of American* Telemetering equipment, Remote-Set Flow Controllers, Pressure and Differential Transmitters, Reliance Motor Valves and American-Westcott Orifice Meters.

Personnel at the compressor station office, located one-half mile from the measurement station, dispatch gas to the American Louisiana Pipeline Company entirely by remote control from Telemetering data.

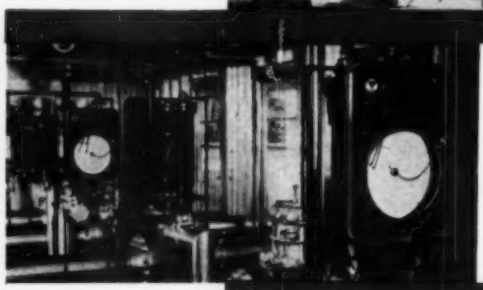
The station is supplied from two parallel 26-inch lines and consists of six 8-inch orifice meter runs between two 26-inch headers. Optimum operating range of the station is 10,000 Mcf per day to 150,000 Mcf per day, with a maximum of 480,000 Mcf per day at 800 psig, should it be required.

This model station is another example of American's precision made, dependable equipment for gas measurement, regulation and control from well-head to burner-tip.

For measurement engineering assistance in your remote control and measurement problems, consult your American Meter representative.



Six Reliance Type CBVA Motor Valves, equipped with valve positioners, control flow — are operated by American Series A-88 Remote-Set Flow Controllers.



Six 8-inch orifice meter runs, equipped with American-Westcott Orifice Meters, accurately measure flows of 10,000 Mcf to 150,000 Mcf per day.

Two-way switches and American Recording Differential and Pressure Receivers, in compressor station office one-half mile away, enable remote setting of flow controllers by station personnel.

AMERICAN®
METER COMPANY
INCORPORATED (ESTABLISHED 1836)

GENERAL SALES OFFICE: Philadelphia 16, Pennsylvania • Albany • Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston • Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood
IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Regina

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters • Instruments • Reliance Regulators • Apparatus • Valves

THE CONFERENCE TABLE

The greatest use of a life is to spend it for something that outlasts it . . . WILLIAM JAMES

Social Insecurity

The Dallas, Texas, District Congressman has more faith in his constituents than any politician we know. Bruce Alger has several times sounded the single or joined in a double "no" of the loyal opposition to popular measures. He decides on principle — not vote-catching qualities — and we're watching fascinatedly to see how long he'll last.

Congressman Alger was one of two to vote against the 7 percent increase in Social Security benefit payments. He explained his grounds for dissent in his Washington report:

1. The Advisory Committee, set up two years ago to study and suggest changes to social security, won't report until later this year.

2. Even after tax increase the payments will be more than taxes. It is not pay-as-we-go; and is actuarially unsound.

3. The $22 billion fund has all been spent, only federal IOU's remain.

4. The deficit of payment to the 12 million present retirees is $65 billion. What will it be for the additional 75 million now paying in anticipating future benefit payments?

5. Payment is compulsory; yet you may never get it back.

Further, the Congressman stated: "Should Congressmen be afraid to speak out and oppose the politically popular measures? Of course not. If we want a social security program why don't we face up to the costs and make it pay-as-we-go. Why don't insurance and business men tell the people the facts of life and make the program actuarially sound? We're all of us *for* providing for our futures."

You might say the Union Welfare Fund Administrators now in trouble have followed the Social Security procedure: Spend the money and get more where that came from.

I often quote myself. It adds spice to my conversation . . .
G. B. Shaw

Early offshore drilling is the theme of this mural at Security Engineering Division, Dresser Industries, Dallas, Texas. The scene includes distant California mountains, derricks on piers, and Texas sage brush and cacti. The composite mural is appropriate for manufacturers of drilling bits. Photo was supplied by Interiors by Cecille, Dallas.

Unbelievable Future

In W. M. Kiplinger's book, "Boom and Inflation Ahead," (Published by Simon and Schuster, Inc., 630 Fifth Avenue, New York 20, New York) the concluding chapter is headed "The Future Is Always Unbelievable." After reading this description of up to 25 years ahead, the future does sound fantastic, but we can believe what the man says and we still think the future is unbelievable. We go along with:

40 million 20-30 year olds.
77 million people by 1980.
$1000 gross national product.
50% inflation in 25 years.
45.6% with incomes over $7500 in 1980.
2,500,000 new houses in 1980.

Mr. Kiplinger and his staff give excellent advice on what to do about it. He has built a good reputation on knowing.

If you are an average American motorist, driving your car 10,000 miles a year, your personal transportation bill will come to $1078 in 1958, an American Automobile Association survey finds. Biggest item — $565 — is depreciation.

Write for Supervisory Aid

American Management Association is putting out a Supervisory Management Newsletter with suggestions on training from various companies. These issues are available to our readers without charge. Inquiries should be directed to Management Editor and should state the writer wishes to be put on the list to receive AMA's Supervisory Management Newsletter.

National Review reports that the United States has the highest per capita debt of any nation — $1591. Great Britain is close behind with $1496. All other nations have debts far under these figures.

Here's a Chance to Check Up On Your Knowledge of English

Here's a quick vocabulary test to determine just how keen your knowledge of English is. Choose the right word for the definition and score yourself as follows, allowing 10 points for each correct answer: 90 or better — you know the Mother Tongue. 80 — better brush up. 70 — language isn't your strong point, work on it. 60 or less — buy a dictionary and get the dictionary habit.

1.	A young deer	fawn	faun
2.	To refer indirectly	allude	elude
3.	Native	indigent	indigenous
4.	Wealthy	corpulent	opulent
5.	To influence	affect	effect
6.	Where bees are kept	apiary	aviary
7.	Express disapproval	deprecate	depreciate
8.	An obstruction	pediment	impediment
9.	Capable of being forgiven	venial	venal
10.	Innocent	ingenious	ingenuous

Turn to Page A-17 for Answers.

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

14 Price-Fixing Charges Dropped

A Federal Court decision delivered in South Bend, Indiana, dismissing price-fixing conspiracy indictments against 14 major oil companies, may serve as a pattern case in the appeal of 29 companies against similar charges brought before a court in Alexandria, Virginia. The indictments were dismissed on the ground that they were returned by an illegally-drawn grand jury. Charges rose from a Federal antitrust investigation in Chicago concerning gasoline prices in the South Bend-Mishawaka, Illinois, area.

Steel Prices Up 2.75%

Armco Steel Corporation initiated a chain reaction among steel manufacturers in early August which elevated prices on most rolled and tubular products. Armco put its new prices into effect July 28, with increases on a dozen products averaging 2.75 percent. Other mills announced similar price rises. One U. S. government economist said that a 2.75 percent increase by all steel manufacturers would mean about $200,000,000 to direct buyers.

Benedum Marks 89th Birthday

M. L. (Mike) Benedum, native of Bridgeport, West Virginia, whose wildcatting made him millions, quietly observed his 89th birthday in Pittsburgh, Pennsylvania, July 17. Benedum, who still keeps office hours, formed the Benedum-Trees companies, which include Plymouth Oil, Hiawatha Oil & Gas, Republic Oil Refining, and Penn-Ohio Gas companies.

Foreign IPE Attendance to Triple

International Petroleum Exposition in Tulsa next May is expecting attendance from foreign countries to triple that of the 1953 show. At that time, oil men from 38 countries attended. To rally the increased international attendance, IPE President W. K. Warren and Governor Gary of Oklahoma are extending personal invitations to ambassadors of 51 nations and to their chiefs of state. Members of the Nomads will assist in registering the foreign delegates and providing them with information.

Crescent, Norbute Approve Merger

Merger of Crescent Petroleum Corporation and Norbute Corporation has been approved by stockholders of both companies. Terms provide that 20 shares of $25 par voting 5 percent convertible preferred stock and 5 shares of Crescent common will be exchanged for each 100 shares of Norbute common stock. Crescent is a natural gas and crude producer in U. S. and Canada; Norbute manufacturers industrial, laboratory and electronic equipment and is also engaged in mineral exploration and development in the U. S. and Mexico.

Imports Increase in August

Crude oil imports into the U. S. have been below the recommended level for the ninth consecutive month, reports Captain Matthew Carson, administrator of the Voluntary Oil Imports Program. Carson has pointed out that the June total was 932,200 bbl daily — about 1900 bbl under the national allocation for that month. He stated that "It is also significant to note that they are 20.2 percent below June 1957 national levels, 28.8 percent below in District V (West Coast), and 17.6 percent below in Districts 1 through IV."

Announced at the same time, however, was a report by the API which counts a daily imports rise of 359,000 during the week ended August 1. Bulk of the increase was posted on the West Coast, where some 418,000 bbl were imported daily — up 349,000 bbl from the 69,000 bbl daily total of the previous week.

Another Tempest at Teapot Dome?

The Navy has selected Intex Oil Company of Bakersfield, California, to drill and operate wells on the Teapot Dome Naval oil reserve. Navy will pay costs of operation plus either a flat fee of $500 per month or 6 percent of the net profits, depending on which is greater. Intex was picked from 31 bidders whose offers ranged from 1 to 33 percent of the profit. Low bidder, Colorado Hydrocarbon Company of Boulder, Colorado, has called for an investigation concerning the contract award. Intex officials say they welcome such a probe, and admit, "We were surprised to get the contract."

Octane Ratings at New High

Gasoline producers of the U. S. still are increasing the octane ratings of their fuels, reports the Bureau of Mines in its latest semi-annual survey. Results of analyses of 6790 samples collected in all parts of the nation show the average regular-price gasoline had a Research octane rating of 90; premium fuels, 98; and super grades, 101.1. Corresponding ratings last summer were 89.8, 97.6, and 100.9. There was a spread in different areas ranging from a low for regular gasoline of 82.8 to a high in the super grade of 102.1.

Russia Becoming Big Oil Exporter

In 1957 the Soviet Union and Romania exported nearly 50,000,000 bbl of oil to the Free World, news reports indicate. Russian production has increased about 15 percent annually since the end of World War II compared with less than 8 percent for non-Communist countries. During the last three years, a report states, production increase has been about 18 percent. Annual crude oil production is now estimated at 721,000,000 bbl, fourth in ratings behind the U. S., Venezuela and Saudi Arabia. Predictions are that Russia will surpass Saudi Arabia this year.

Oil Industry Not at Peak

The petroleum industry, on the eve of its 100th anniversary, has not yet reached its greatest area of growth, says Robert L. Wood, chairman of the executive committee of IPAA. He predicts that the domestic industry will be able to meet future demands, and that its future possibilities are unlimited. To keep abreast of expected demand and provide a cushion of reserve oil-producing capacity, the industry should drill about 700,000 new wells in the next 10 years. Drilling on this scale would require expenditures of about $75,000,000, Wood estimated.

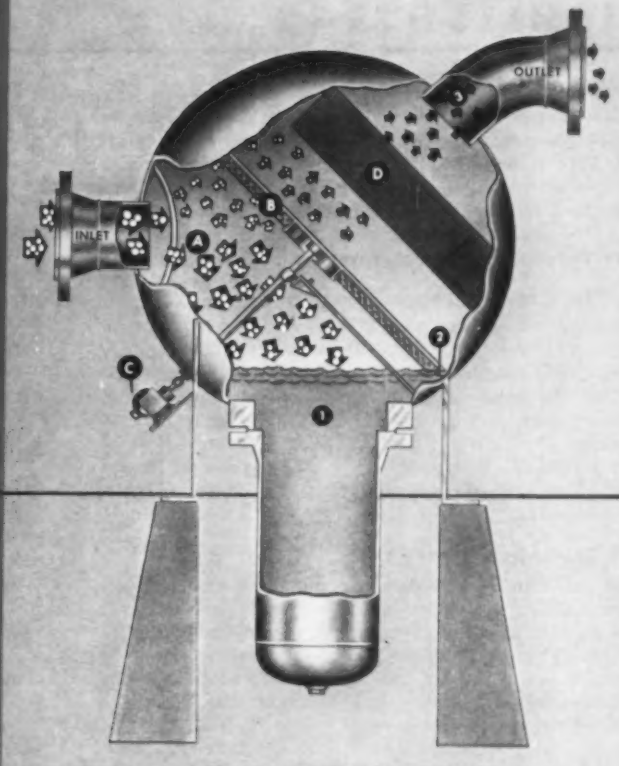
Sooner Maximum Output Near

Oklahoma is nearing its maximum efficient production rate, reports Massena B. Murray, director of the state conservation department, in a recent report to the allowable-setting OCC. He indicated to the conservation commission that Oklahoma cannot produce a great deal more oil each day unless it wants to endanger ultimate recovery and that "The amount of oil which the state can produce without waste has been decreasing daily until the current MER is something under 600,000 bbl a day." Purchaser nominations for Oklahoma oil in August totalled 558,400 bbl per day.

MORE EFFICIENT RESULTS!

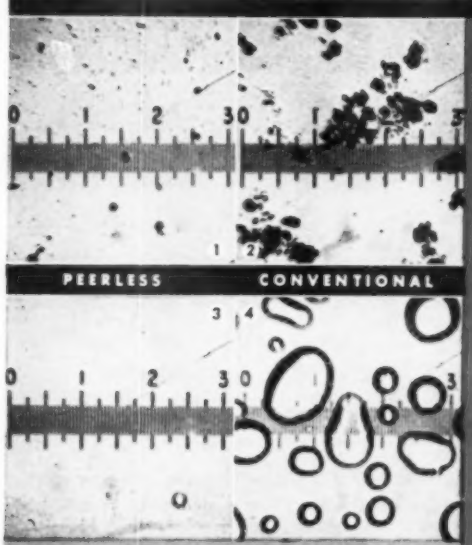
PEERLESS SCRUBOSPHERE*

*Spherical scrubber for dust and liquid removal from gas flow



LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).



These photographs were made of microscope slides introduced downstream of the Scrubosphere and a conventional vertical oil bath cleaner under the same operating conditions. Plates 1 and 2 show the comparative amounts of iron oxide not removed with the amounts introduced being identical. Plates 3 and 4 indicate comparative oil loss with vapor rate through the vessels being the same.

LOOK AT THIS TEST The test at the left indicates the superiority of Peerless Scrubosphere over conventional oil bath dust scrubbers. The SCRUBOSPHERE operates with no loss of efficiency at low flows, minimum liquid loss, and very low pressure drop. Other outstanding features include easy vessel access with removable self cleaning contactor, a sump for slugs of solid or liquid particles, and minimum cost.

For detailed information write for Bulletin No. 180

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P.O. Box 13165 Dallas, Texas

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PEERLESS MFG. CO. DALLAS TEXAS

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

HIGHLIGHTS—2

Digest of News and Comments

Depletion Cut Defeated

Two attempts to cut the 27½ percent depletion allowance were soundly defeated in the Senate in mid-August. Both were in the form of amendments to a catch-all excise tax revision bill, and were introduced by Senators John Williams (Delaware) and William E. Proxmire (Wisconsin). One amendment would have cut the allowance to 15 percent; another would have provided a graduated reduction.

El Paso-PNW Merger Hearing Set

Federal Power Commission has scheduled hearings on the proposed merger of the El Paso Natural Gas Company with Pacific Northwest Pipeline Corporation. Acquisition of PNW has been before the Commission since August 1957. Justice Department has on file a suit objecting to El Paso acquiring Pacific stock. Paul Kayser, president of both El Paso and Pacific Northwest, has pointed out that the merger would help natural gas development throughout the intermountain area.

Oil Big Atom User

Seventy-four oil, petrochemical and allied companies are using radioactive isotopes as an everyday part of their business. Of 31 company-owned radiation centers, seven are owned by oil companies. In the oil industry, said to be the most diversified user, radio-isotopes are used for gaging thickness, for wear studies, leak detection, and research to improve refinery processes.

Pan Am, Argentine Sign Pact

Pan American International Oil Company has signed a 15-year contract with YPF, official Argentine oil company, whereby Pan Am will receive $1.60 a barrel, after taxes for all Argentina oil delivered to storage facilities. Contract requires the U. S. company to develop the South American country's reserves to the fullest extent and as rapidly as possible. Fifty wells are scheduled for the coming 12 months, and a 40-mile pipeline is planned. Pan Am hopes to develop a rate of delivery of about 30,000 bbl a day within 24 months. YPF has agreed to pay about 60 percent in U. S. dollars.

Tankers, Anybody?

U. S. Maritime Commission reports that 187 new vessels were added to world tanker fleets last year. Only 8 were delivered from U. S. shipyards, but all went to privately owned fleets within this country. Liberia added 55 ships to the world's number — including three of more than 85,000 tons. U. S. tankers were all between 17,000 and 40,000 tons. Norway added 37 tankers and the United Kingdom, 28. Current tanker activity has been light, with the U. S. market centered around Military Sea Transportation Service requirements.

Pipelines Challenge Appeal

Service, Tidal and Arapahoe pipeline companies have filed briefs challenging the Justice Department's appeal from a federal district court edict upholding their dividend payment practices. The government lost on all counts last spring and appealed the case August 23 to both District of Columbia court and to Supreme Court. At issue is whether or not the companies can pay 7 percent dividends to oil company owners, who are also their principal shippers, on the company's valuation rather than its original investment.

U.S.-Venezuela Travel Increases

Passenger air travel between the U.S. and Venezuela increased 15 percent during the first three months, according to an air traffic analysis released by LAV, the Venezuelan airline. During the first three months of 1958 a total of 20,749 passengers flew between the two countries compared to 17,980 passengers in the same period in 1957. U.S.-Venezuelan traffic accounted for 40 percent of all air travel between U.S. and South America.

Two New Editors Appointed by The Petroleum Engineer

J. E. "Hank" Kastrop, former editor for The Drilling and Producing Edition of *The Petroleum Engineer* for the past 3½ years, was recently appointed editorial director for The Petroleum Engineer Publishing Company. He is succeeded by Jack W. Williamson, former Continental Oil Company engineer, assistant production superintendent, petroleum consultant and independent operator of Dallas, Texas. Both appointments, according to Joe B. Woods, president, were made to expand the scope and activities of the editorial department, and to permit Frank H. Love, who formerly served as editorial director, to devote full time as editor of *The Pipeline Engineer*, one of the specialized editions.

Kastrop is a petroleum engineer graduate of The University of Texas (1941) and worked as a roustabout, junior field engineer, production engineer and drilling engineer for Humble Oil & Refining Company in West Texas and South Louisiana. After four years in the U. S. Naval service during World War II, he joined The Gulf Publishing Company at Houston, Texas. He was an engineering editor on the former *Oil Weekly* and after nine years as a petroleum engineering editor, he left *World Oil* in 1955 as production editor to join *The Petroleum Engineer* as editor of The Drilling and Producing Edition.

Williamson is also a graduate petroleum engineer. He received his BS degree from The University of Oklahoma (1942) and worked as an engineer in the aircraft industry prior to serving with the U. S. Army Engineer Corps during

J. E. "Hank" Kastrop

Jack W. Williamson

World War II constructing pipelines and gasoline storage terminals in the Pacific. He joined Continental in 1946 and worked up from roustabout, field engineer (he helped set up Conoco's North Cowden office north of Odessa, Texas) to production engineer in the company's Fort Worth, Texas, regional office. From 1953 until 1955 he was assistant production superintendent for Woodson Oil Company at its Breckenridge, Texas, office. He later became president of a wire line service company at Abilene. Prior to joining *The Petroleum Engineer*, he did petroleum engineering consulting work, and for the past year was an independent operator.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Good Wells Make Good News

A Monthly Report of Successful Well Treatments

September, 1958

Acidizing, as well as fracturing, should be considered when planning a stimulation treatment. Acidizing may actually be the most profitable treatment for your well. Here are four recent examples of successful acidizing jobs by Dowell.

- **Crane County, West Texas.** (New Oil Well) This well was completed in the Silurian-Montoya dolomitic limestone (5110 to 5114 feet). It swabbed only 3 barrels of oil and then went dry. Operator ordered 500 gallons BDA* (Breakdown Acid) to prepare well for fracturing. *After treatment with BDA, well came in 110 bopd flowing—without fracturing.*

- **Southeastern Saskatchewan, Canada.** (Old Oil Well) This was completed in July 1957 in the Charles. Casing was perforated in four intervals between 4476 and 4510 feet. After initial acidizing, production rose to about 60 bopd but gradually decreased to 22 bopd. Dowell was called to treat the well with the retarded acid-action fluid used in Acid Petrofrac*. 5000 gallons fluid and 80 ball sealers were used. Treatment was down casing at 8 bpm. 20 ball sealers were injected after each of the first four 1000-gallon batches of fluid. Four days after treatment, *the well was pumping 55 bopd. The producer figured that the treatment cost of $3295 paid out in only 35 days.*

- **DeSoto Parish, North Louisiana.** (New Gas Well) Completed through perforations (6340 to 6350 feet) in the Pettit limestone, this well made a show, but no production. Dowell was called to acidize. First, 2000 gallons of acid containing demulsifying agent was used. Then 6000 gallons Dowell X Acid was pumped into well at 5.8 bpm, and displaced from tubing with water. *After clean-up well potentialed 52 mmcfd open flow.*

- **Russell County, Kansas.** (New Oil Well) This well was completed in the Kansas City limestone but produced less than 3 bopd. The producer ordered a treatment of 3000 gallons Retarded Acid spearheaded by 250 gallons BDA (Breakdown Acid). *After clean-up following treatment, well tested nearly 2000 bopd.*

Your zone pay may be a relatively insoluble sand or a fast-reacting limestone. In any case, acid may be your best buy. Let your Dowell engineer help you "tailor" an acid treatment for your well. In some cases the acid may be used to remove mud blocks. In others, it may increase the drainage area of the well or improve fracturing results. For service, call any of the 165 Dowell service points and offices. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

Services for the oil industry DOWELL

A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY

KOEHRING® 3/4-YARD 305 HOE

TRACTOR-TYPE CRAWLERS are available on Koehring 305 for operating over rough cross-country terrain — *plus* independent 2-speed traction (optional).

25-TON CAPACITY ON RUBBER . . . Mobile, truck-mounted 305 (above) has crane-clamshell-dragline-shovel-hoe versatility. It's also available as a 25-ton Cruiser® crane, with one-man operation, and 18 mph mobility. Other Koehring sizes: cranes from 10 to 95-ton capacities. Shovels from ½ to 3 yards.

K841

It's heavy-duty . . . with a big "plus" in extra work capacity

There are several good reasons why you should look into this Koehring heavy-duty ¾-yard hoe. For one thing, you get exceptionally wide work range on cross-country trenching, or slush pits, footings and other below-grade excavations. As a pipeline machine on tractor-type crawlers (optional) it digs 19 feet-9½ in. below grade. Long reach puts spoil bank well back beyond edge of cut — or gives up to 12 foot-10 in. clearance height (at beginning of dump) to load trucks. ¾-yard dipper cuts 40 inches wide over sidecutters.

Antifriction power-flow on dig, hoist, swing and travel assures smooth, dependable operation under maximum loads. Main-drum power clutches require only *1/10th* the lever-pull of comparable-size manual clutches — yet retain accurate "feel" of load. Maintenance on the heavy-duty 305 is simplified, too, because there are only 2 main shafts in the upper machinery. Each assembly is an independent unit with fully-enclosed gears, and splined shafts rotating on antifriction bearings.

You get more work done with every 305 attachment: ¾-yard hoe, shovel, ¾ to 1-yard clamshell, dragline, 15-ton crane. Call Koehring distributor.

KOEHRING
DIVISION OF KOEHRING COMPANY
MILWAUKEE WISCONSIN

Koehring excavators, cranes also manufactured in:
CANADA • ENGLAND • SPAIN • JAPAN

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Chemical Reaction

"If man is really the mere inevitable culmination of an improbable chemical reaction, then the fact that he has been able to trace himself back to it is indeed remarkable. The idea that a chemical can understand its own nature is actually staggering." *Joseph Wood Krutch.*

Management Looks to Engineers

Faced with the prospect of an ever larger organization, business today realizes as it never did before the need for adequate development of men for management.

This was the message brought to Texas American Institute of Electrical Engineers sections by John Gammell, manager of the Graduate Training Department, Allis-Chalmers Manufacturing Company, Industries Group.

Engineers are one of the major groups from which industry draws men for management, Gammell said, because right from the start of their careers most engineers have some managerial responsibility. Today about 40 percent of all industrial executives are engineers and about 34 percent of all engineers rise to positions with high executive responsibilities.

The possibility of this trend continuing is quite apparent as the problems of management become increasingly technical in nature, he declared. At one time financiers were the most influential group in industry because obtaining capital was a major problem. Lawyers took the lead after the turn of the century as anti-trust laws created legal problems.

"The group that's now between 20 and 40 — the source for executives — 25 years from now is a small group from the birth barren 30's and smaller population 20's. They will have the problem of managing "things" to produce far more per capita than ever before. These young men now starting on their careers are going to be mighty busy and important people. We must train them well and broadly. They must lead well in order that others may follow well," the speaker said.

Research High and Wide

We are always fascinated by what the researchers go after, and remarks of M. J. Rathbone, president of Jersey Standard, to the annual stockholders meeting gave some interesting projects of the people who search for new uses of petroleum. He said:

"We are hopeful that work now in progress will help convince many customers that they can conveniently and economically cool and heat their homes with oil on a year-round basis. Research is going forward on methods of using oil to melt snow at large installations such as airports and parking lots, to kill fungus on banana plants, to protect orchards from frost, to control evaporation from water reservoirs, to improve methods of irrigation, and to use asphalt as a structural building material.

"Some of these and many other ideas may come to dead ends, but some are just as likely to develop into profitable operations for the future. We think our 'Committee on New Uses for Petroleum' is one of our most important activities."

Capital Expansion Survey

Recently Walter Kidde Constructors surveyed presidents of the 500 largest industrial corporations as compiled by *Fortune Magazine*, in order to arrive at the capital spending in 1958-59 if Congress legislated a five-year write-off. The results in brief showed that the five-year write-off would have little influence at this time. However, there was interest in modifying present write-off provisions permanently to permit more rapid amortization.

Outstanding point revealed was that although the survey showed lower capital spending planned in 1959 than in 1958, two industries, petroleum and food, indicated continued spending at 1958 levels. In fact, according to the figures, capital expenditures would rise slightly in 1959 according to the 14 oil companies that replied.

U. S. Atomic Policy

At the 12th annual American Assembly held at Columbia University, New York, last December, the subject was "Atoms for Power." Complete coverage, including background papers and panel discussions are published by the University and single copies are available without charge by writing to the University.

The American Assembly is a program of conferences of leaders in business, government, professions, labor, etc. The meetings develop recommendations on issues of national concern. Two trustees are from the petroleum industry — W. Alton Jones, Cities Service, and Leonard F. McCollum, Continental Oil.

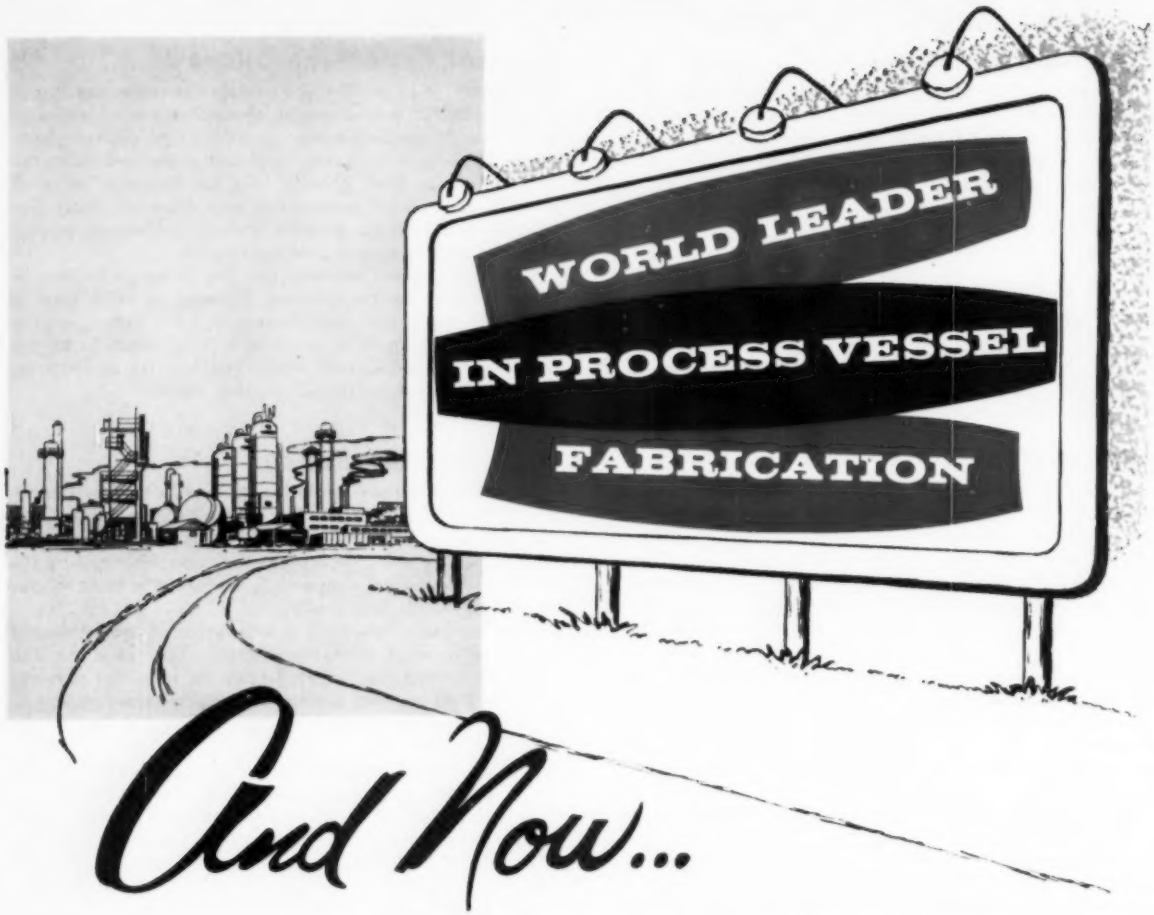
"Atoms for Power" collects the history and influence and some economics of atomic energy. It is good background book although what we consider the most important phase — use of nuclear energy in research — is dismissed with one paragraph and that concerns power generation. It is our understanding that the petroleum industry more than any other has used atomic energy in research.

He that was only taught by himself had a fool for his master . . . Ben Jonson

ANSWERS TO QUESTIONS ON PAGE A-11

Definitions based on the Thorndyke-Barnhart Comprehensive Desk Dictionary.

1. Fawn — a young deer less than one year old.
   Faun — a minor Roman rural deity with the body of a man, but horns, tail, and hind legs of a goat.
2. Allude — to refer indirectly.
   Elude — to avoid or escape from by quickness or cunning.
3. Indigent — poor, needy.
   Indigenous — native.
4. Corpulent — fat, fleshy, stout, obese.
   Opulent — wealthy, rich.
5. Affect — influence, produce a change in.
   Effect — to bring about, to cause to happen.
6. Apiary — place where bees are kept.
   Aviary — a large cage for keeping many birds.
7. Deprecate — to feel and express disapproval.
   Depreciate — to lessen in value.
8. Pediment — a low pitched gable on the front of some buildings in the Grecian style of architecture.
   Impediment — anything that impedes or obstructs.
9. Venial — that may be forgiven.
   Venal — that can readily be bribed.
10. Ingenious — clever, resourceful, inventive.
    Ingenuous — artless, innocent, naive.



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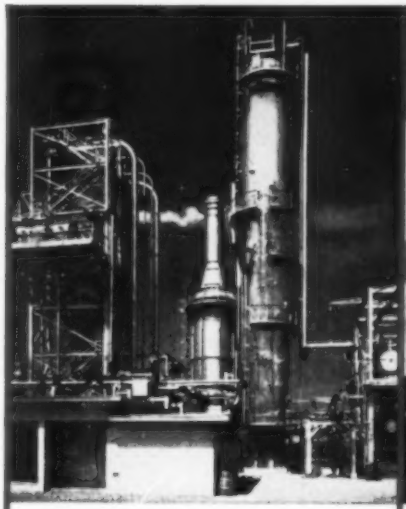

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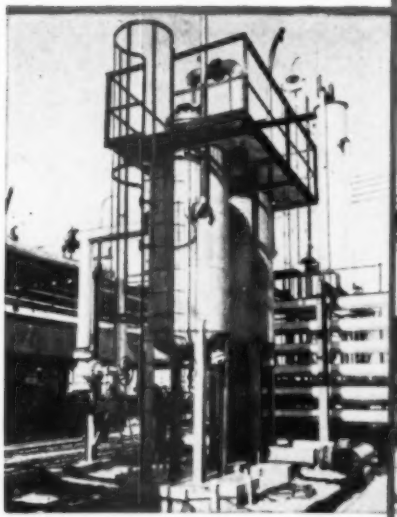

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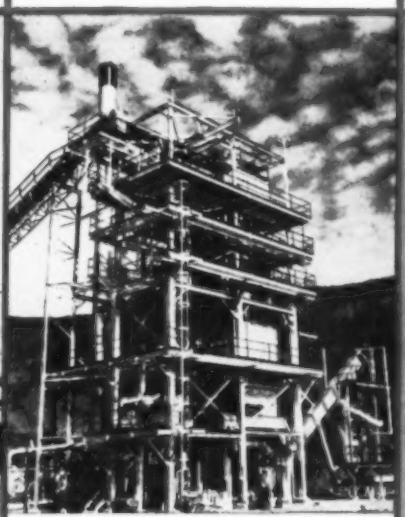

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For more information, send for Bulletin 2547, "Petroleum Processing Plants." It describes Blaw-Knox services and reviews results achieved for the industry.

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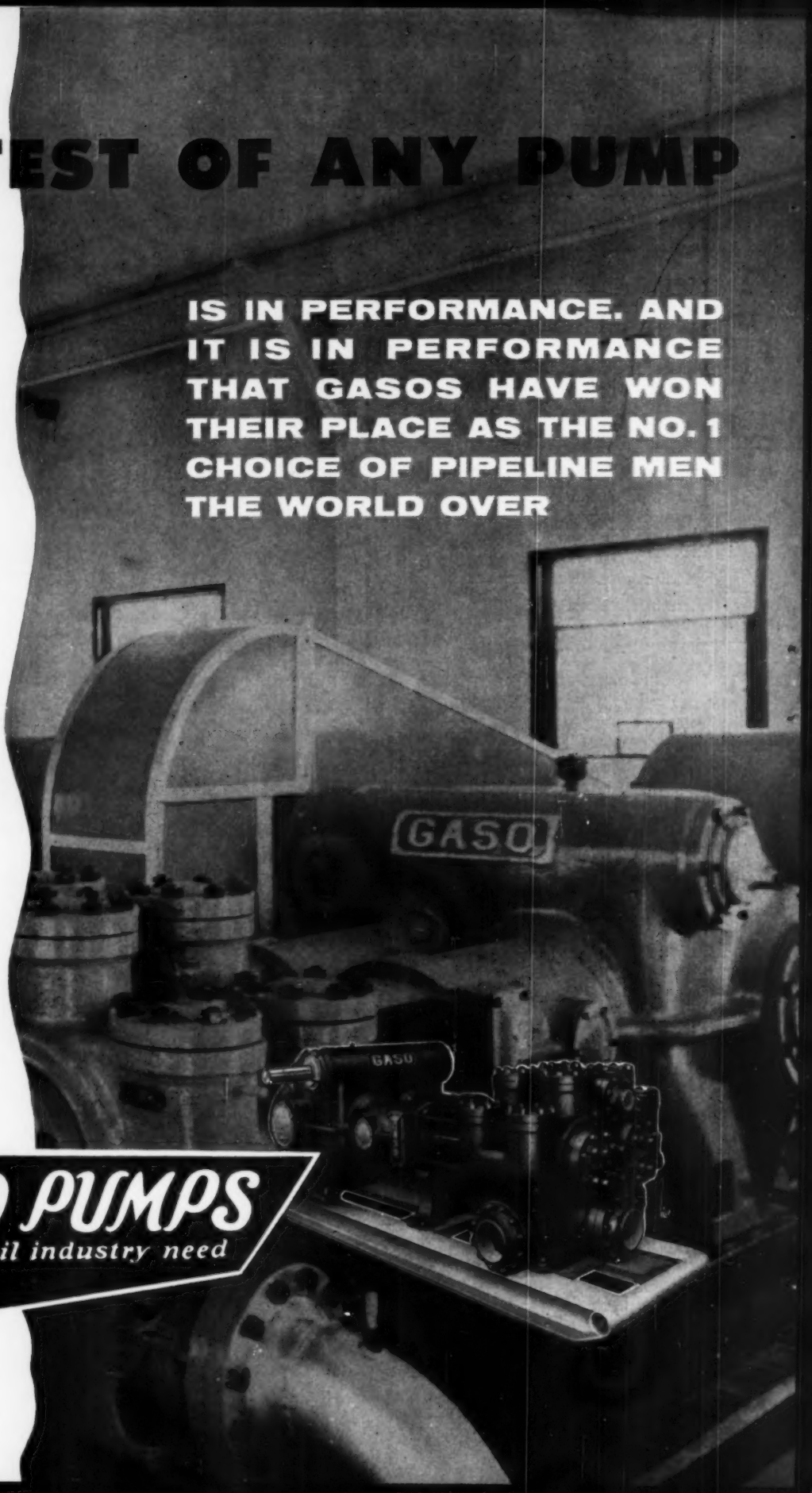

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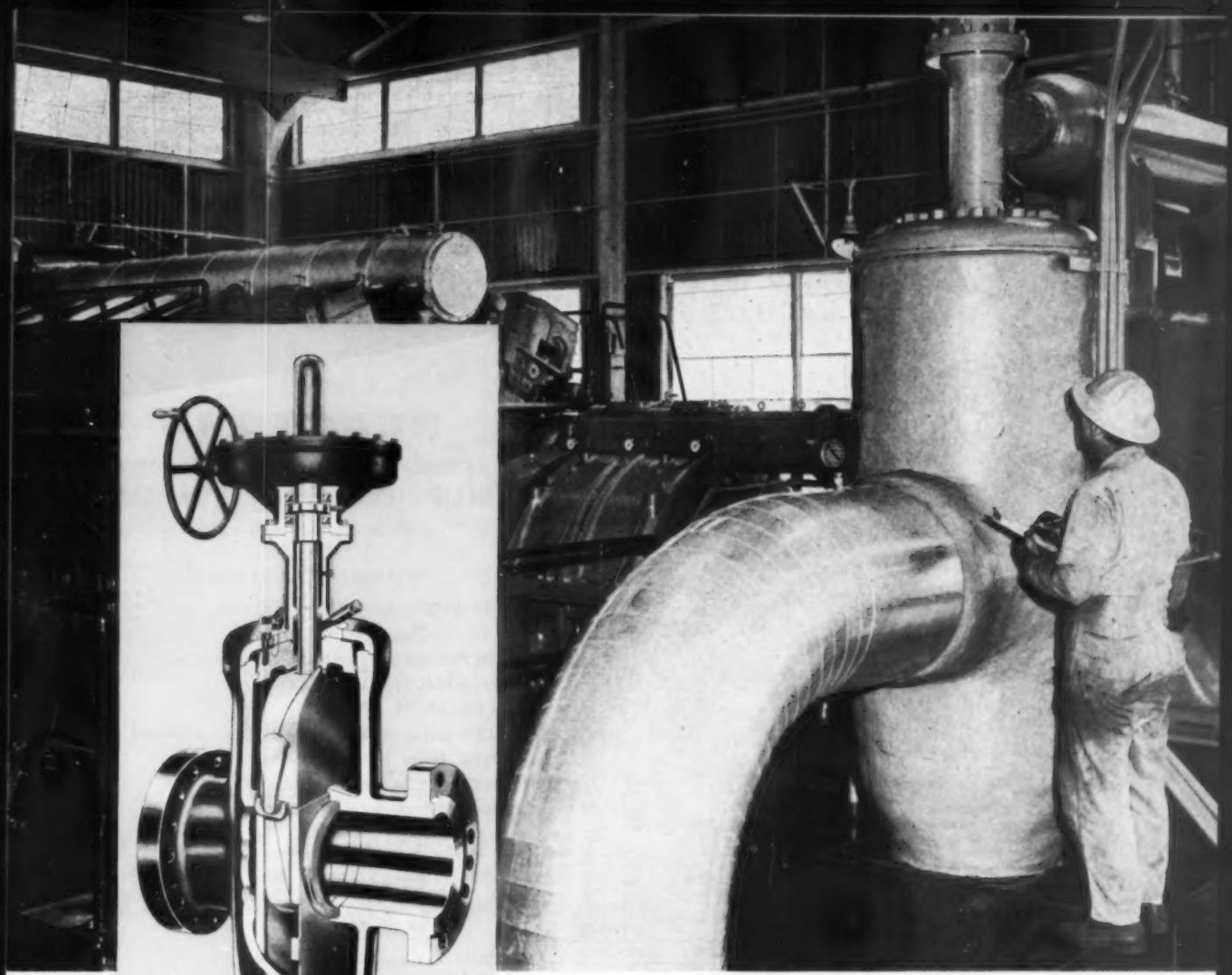

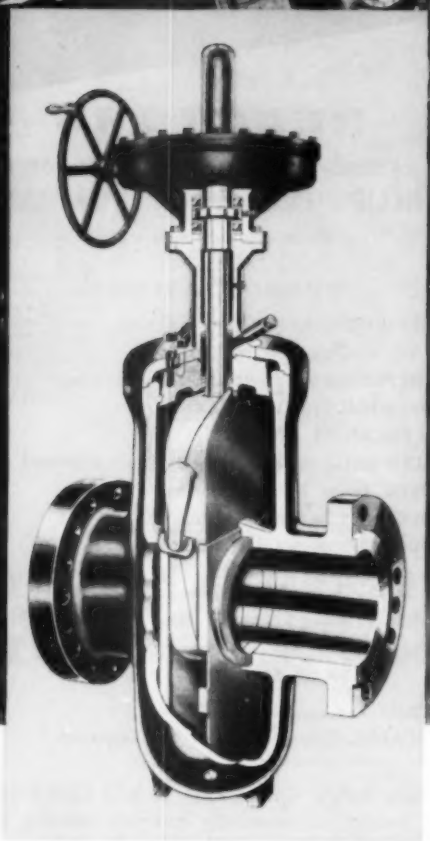

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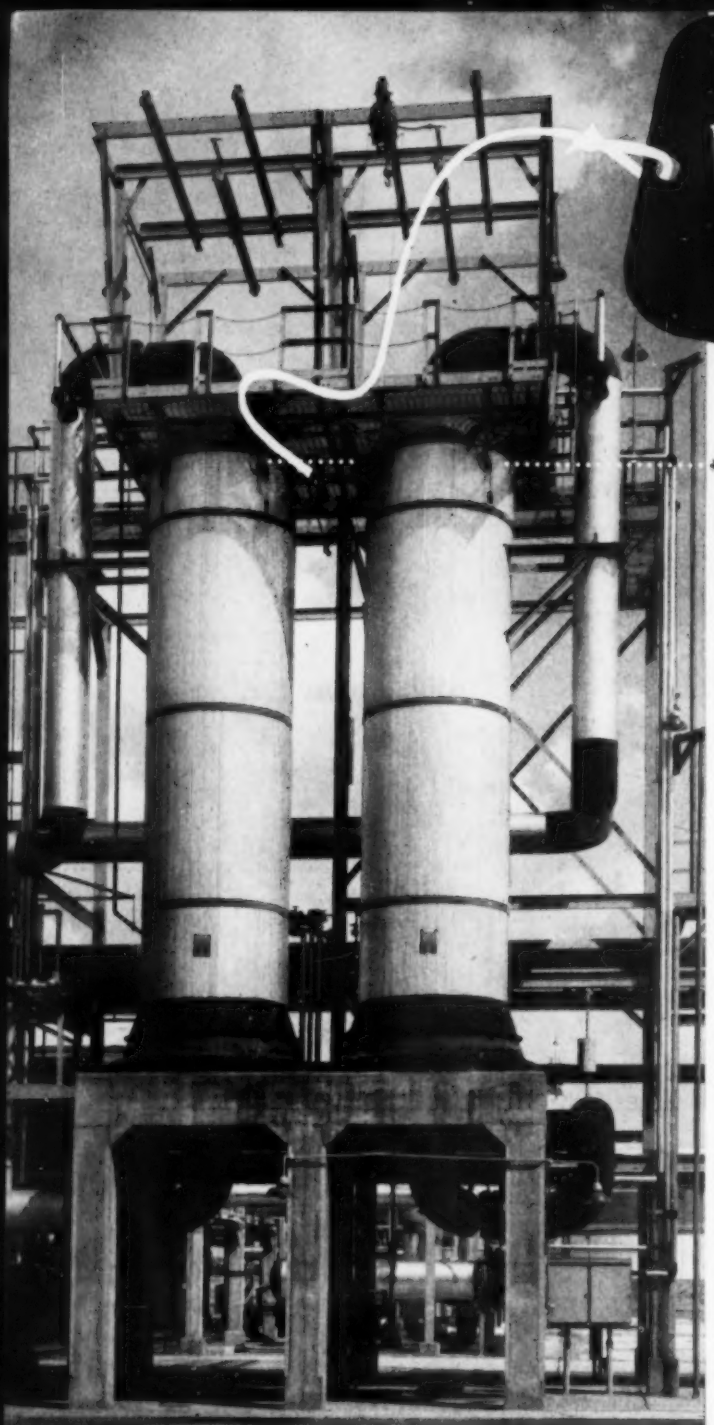

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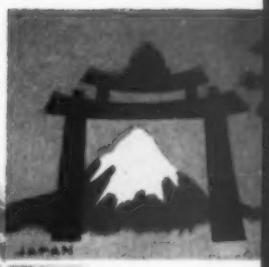

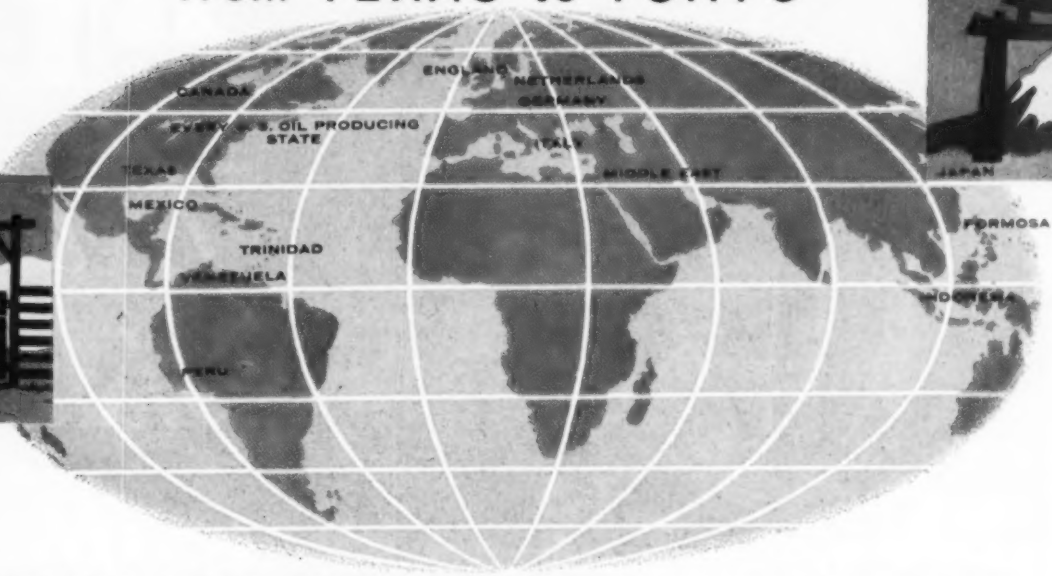

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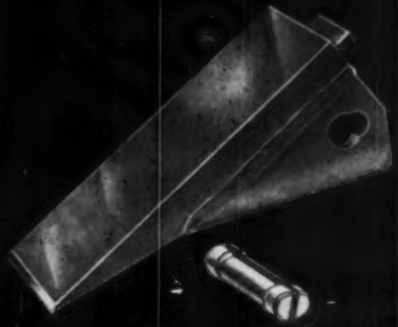

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YOUR WRITING CAN GET ACTION

These seven steps will assure better results from your reports and memos

Jo Chamberlin

MORE AND MORE BUSINESS decisions are being made on the basis of a memorandum, a written presentation or report. This is an inescapable part of growth.

Expansion of companies, sales territories and product lines has made the former practice of presenting ideas across a desk impractical. Continued growth of business is likely to make the written word even more essential as a time-saving and useful instrument for advancing projects within an organization.

This kind of writing is not easy, even with practice. But there are ways of making it easier for both writer and reader. The steps include:

- Put idea in one sentence.
- Organize your thoughts.
- Keep it simple.
- Cut and condense.
- Ask criticism warily.
- Get eye appeal.

No executive should feel inferior because he can't sit down and dictate a clear, complete memo at one sitting. Experienced business writers go over their copy repeatedly. The simpler it reads the more time it takes. They spend hours doing what has been described as the only way to improve one's writing: Applying the seat of the pants to the seat of a chair.

Put Idea in a Sentence

Assuming that you've done the requisite fact finding and legwork, write down the essence, the gist, idea, or theme of what you are going to say. The sentence doesn't have to be fancy, catch or brilliant. It can be as simple as: How this company can make more money with fewer vice presidents.

Organize Your Thoughts

It is a good idea to think of your memo as being what you would say to your business associates, if you were talking across a desk. You might say, in effect, "This is what I propose we do, why we should do it, what it will cost, and how we can get things rolling." There you have a logical organization of thought.

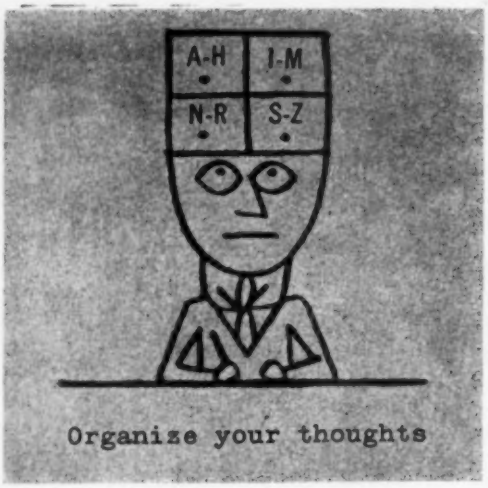
In *Nation's Business* for June, 1957, there was an article entitled "How to Simplify a Problem." Any problem was broken down into six steps: 1, identify the problem, 2, gather data, 3, list possible solutions, 4, test possible solutions, 5, select the best solution, and, 6, put the solution into action.

This pattern will serve for many memos or reports.

This is the place to consider what you can and can't say. There are inherent or built-in limitations on what any executive can say, even for internal consumption.

It is obviously unwise to go out on a limb unnecessarily or try to forecast the future. But many business memos are unduly cautious in places where they don't need to be.

Often an executive says, "We can't say that. It's against company policy." I always suggest that we check to make



sure. Sometimes the policy does prevent us from saying something, but occasionally the policy in question turns out to cover something else. Or, a phone call may develop that the officer who formulated the policy has changed his thinking, or the company has done so.

There are ways to say what you think, and still leave a door open for any future re-examination if that becomes necessary. As a rule, let the facts speak for you: "The evidence indicates . . ." "Statistics suggest . . ." "Research shows . . ." "Recognizing the limitations of our data, I recommend . . ." and then say what you want to say.

There are times when it is wise to use *may* or *might, could* or *should,* but don't overwork them.

Make It Simple

High-sounding language is no substitute for facts and ideas. Sound thought comes through on paper. Nor can you bridge or gloss over a contradiction of fact or conflict of thought with fancy language.

Some executives also feel that being impersonal gives dignity and some kind of institutional strength to their words. It more often results in vagueness, even stuffiness, rather than dignity. Impersonality also makes it easy for a memo writer to fall into the trap of the lofty generality and the noble statement of purpose, rather than the hard fact of reality.

The pronouns *I, you,* and *we* are in the spoken and written language to be used. All forceful writers have used them, from the Old Testament to Jefferson, Paine, Lincoln, and Churchill.

The second person, *you,* will help give your words what a corporation president described to me as *you-ability* — suggesting the two-way exchange of ideas. The first person plural, *we,* certainly conveys a picture of the management team, regardless of any private misgivings you may have on the point.

This will also help you avoid using impersonal subjects and verbs all the time, such as, "The corporation expects . . ." "Management thinking is . . ." "It is believed that . . ."

The business executive can also use the techniques of the professional writer to make his work come alive. He already knows many of them and only needs to be reminded of the others. They include:

a. *A good lead.* You should have an interest-arousing first sentence and first paragraph. Usually, a writer uses what strikes him as best, or strongest. It can be a meaningful quote, a clear statement of the problem and proposed solution, an anecdote or illustration which dramatizes the issue, a striking and simplified statistic, or a question addressed to the reader's self-interest.

You should also prepare a forceful ending since this will be the last impression you leave in your reader's mind. All the lead suggestions can also be considered for your ending. Select one which best serves your purpose.

b. *Quotes.* In this kind of writing, you will not get much help from a book of quotations or dictionary. Talk to the people on the job. They may not fully grasp the big picture but they are often more articulate (or less inhibited) than their bosses.

An office worker, factory employee, or freight handler will often say something in language more vital and meaningful than anything you can think up. He may sum up in 10 words what you are trying to say in 100.

c. *An anecdote* or concrete illustration makes a point just as well in writing as in a talk. Name names, if desirable. Use people to illustrate situations, problems or attitudes. If you're talking about farmers, you'll usually do best (and keep from running all over the lot) if you concentrate on one farmer or a few. Wrap as much of your story as you can around him.

d. *Use simplified statistics,* but don't throw a solid block of figures at your reader. He doesn't like to plow through them any more than you do.

e. *Contrast* — setting the good alongside the bad, the efficient by the inefficient — is often made good use of by executives in their speeches. But they seldom use contrast in their writing, where it can do an equally impressive job.

f. *Establish credibility.* The characters we never forget in novels, plays, and films are people who have flaws as well as virtues. We all recognize that both people and organizations have flaws. Yet some executives tell me that it weakens their case if they include too many negative things or liabilities, along with the assets and strong points.

On the contrary, to admit frankly that your project has a

few weak points or that major obstacles must be overcome establishes credibility. Your reader is much more inclined to believe you, and go along with you.

If you know opposition to your idea exists, it is usually best to state it, and your understanding of the reasons for it, and let the reader decide for himself. Don't belittle your opponents, or imply self-interest. Give them the benefit of honorable intentions, whether they have them or not. Also give proper credit to those who support your idea.

g. *Vary the length of your sentences.* Make some short, some longer.

You will probably not be able to use all these writer's techniques in any one memo, but you can use those which are appropriate to your subject matter.

Make Things Easy for Your Reader

If you refer to some company policy, magazine article, or newspaper story, don't expect your man to remember it or look it up. He's busy, too. Quote whatever parts are pertinent. He could also remember it differently than you do. Insert, if you want to, a phrase such as, "We all recall that President Rowe said on June 15" — or "The company directive on this matter dated May 15, as you know, stated . . ."

If you don't want to insert a long quotation or batch of figures in your memo, put it in an appendix.

This accompanying documentation satisfies the suspicious executive who double-checks everything, and impresses the more casual type who will merely glance at it.

Explain any technical or professional terminology as you go. No one will be insulted.

Above all, tell you reader what you want him to do.

When Dwight D. Eisenhower was president of Columbia University, I had the honor and pleasure of working with him on a number of matters. If possible, he liked a problem put to him in a memorandum, with supporting data appended. At the end of the memo, he liked to have the possible solutions listed, along with the writer's recommended solution, who would carry it out, and what would be the first action steps. He then initialed the solution he approved. The man who wrote the memo was thus committed to carry it out, or help carry it out.

Mr. Eisenhower took great pains writing and re-writing important letters and public statements. He once casually remarked to me on style, "I don't use many adjectives or adverbs."

Mr. Eisenhower's follow-up technique with memoranda is effective, but you can't follow it precisely, if you are shooting up from farther down the executive ladder. Yet it does suggest one way of initiating action, after your memo or report is completed.

It is hard to accept the fact that, after you have knocked yourself out on a project, your associates will not enthusiastically pitch in and help you, but in my experience they won't. In their minds you are still carrying the ball.

To have active support, you must be specific about how the reader can help get things actually started.

Cut and Condense

A first draft is usually discouraging. The thought content will seem fragmentary and there will be holes to fill. The second draft should hang together better. The third draft will approach what you finally wish to say — and so on.

Cutting takes time, and is exacting work. Often it is better to cut whole sentences, and whole paragraphs, rather than to reconstruct or rewrite individual sentences. Sometimes a strong verb will do the work of a whole sentence and eliminate many adjectives.

Only amateur writers think that adding a lot of words like efficiently, promptly, thoroughly, thoughtfully add force to their manuscript.

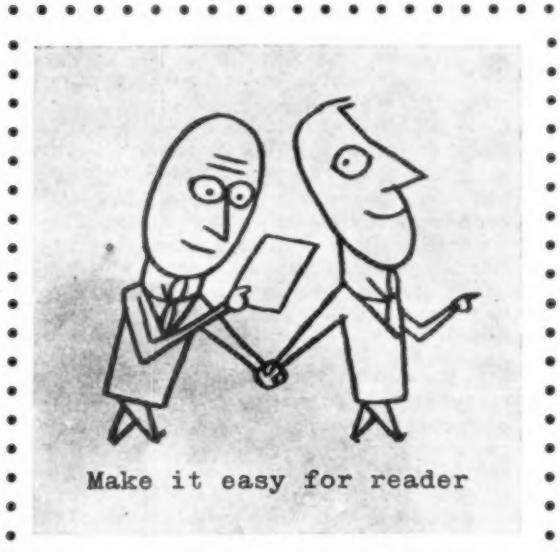
But don't hesitate to use unorthodox, unusual, or aptly colorful words.

I recall reading one business report in which a personnel specialist was advising his client to "develop his blue chip men to the limit of their capacity; make up his mind about his maybe men, and improve or replace his poor performers."

We knew exactly what he meant.

Go through your manuscript word by word and sentence by sentence. Ask yourself of each, "Does this contribute directly to the telling of the story, does it lead directly toward my goal?" If not, the word, phrase, or sentence comes out. Some of your most cherished phrases or pet passages will fall victim to this harsh rule.

Another way to cut a text is to read it aloud. Your ear will



tell you the excess words which should come out. Radio writers do this with their scripts. The method works especially well with speeches.

Make several trips through your text with a pencil. Cut a word here, strengthen a phrase there. You may wind up with a total wordage cut of only 10 to 20 percent, but this small cut can possibly give 100 percent more effectiveness to your writing job.

Ask Criticism Warily

Submit your memo in draft form to other executives for criticism with caution, providing you know your man. To be blunt, he may try to steal your idea, or torpedo it if he doesn't like it. Most people will point out small things, such as misspelling, or typographical errors, but pass over main points of thought. However, submitting an idea in advance to some individuals may help obtain their support later. Never submit a rough or incomplete draft to anyone. Some people lack the imagination to visualize the end result. Submit it in almost-final form to a few people you trust. Don't expect to get many really thoughtful critiques.

If you send your memo to someone solely for his information, say so.

If you submit it to others for criticism, be sure that they understand whom the memo is for and what it is designed to do. Attach this data firmly to the draft itself. The recipient of your brain child may pass it on to someone else (after removing your accompanying explanatory letter) with something like, "Here's something that will interest you," or "Take a look at this." If you want that one person only to see it, say so plainly on the memo and in a transmittal note.

In many cases opposition arises, not from the thought or ideas in a memo, but from a simple lack of information as to its aims and audience.

Executives often will agree in principle, and solemnly assure each other that they see eye to eye on a policy but, when a text is put before them, they can disagree over almost every word and sentence. You must expect this. They will often argue semantics, and suggest minor changes until there is so little time left for important substantive matters. So, if you desire criticism and comment on your memo, get it from your associates individually. Don't call a meeting.

It will help you obtain criticism if you ask your potential critic specific questions such as, "Have we overlooked any markets?" or "Will you mark any passages that can be cut?" I often suggest, in a transmittal slip, that the person give me his comment over the phone. Nobody likes to write any more than he has to, or go on record without further examination of the whole project.

How you keep company lawyers from taking the force out of everything you say is your problem. This applies more to external documents than internal ones. Some lawyers, who would blow their tops if you advised them how to prepare their briefs, will not hesitate to tell you how to write.

I'm oversimplifying here, but make sure your lawyer is expressing legal, not personal, editorial opinions. He may be a frustrated journalist.

Get Eye Appeal

Use the best quality paper and the finest reproduction process available. Men dislike reading carbon copies, if they have any choice. If your memo is reproduced from a typewritten page, have at least one inch margins all around. If typed single space, allow a double space between paragraphs, and make some paragraphs short.

If practical, break up your entire text into sections. A paper binder protects a memo, and enhances its appearance, particularly if it is to be kept.

One corporation insists on a summary of longer memos or reports on the title page, a helpful practice borrowed from scientific papers. In this summary don't tell it all — make the reader want to go on.

If your memorandum has been well executed, it will have alerted, informed, and convinced key people in your company. You can continue its distribution—it will reply to questions, answer objections. It will reach a great many more individuals in your company than you could possibly reach personally. ★ ★ ★

If you want more complete material on communications write The Petroleum Engineer, Box 1589, Dallas, Texas, for Dr. Dennis Murphy's popular "Common Sense Approach to Better Communications." This 12-chapter handbook not only tells you how to write but also: How to think creatively; how to improve your telephone personality, how to give instructions — all in clear, easy-to-read language. One book that will help improve yourself and your whole outlook. Send $1.50.

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U. S. government provides complete correspondence course for executives to study problems of national crises and how to manage during an emergency economy

IT IS NEVER possible to blueprint a national emergency — but the Industrial College of the Armed Forces provides an opportunity to prepare for one. A correspondence course called "Emergency Management of the National Economy" is offered without charge to executives who qualify.

Objects of the course are to teach you —

1. **To appreciate through personal study the fact that there is no easy nor single answer to national readiness for emergencies.**

2. **To broaden the basis for your executive decisions by improved understanding of the complex problems involved in national security.**

Eligibility

Persons eligible to take the course are those, either military or civilian, who hold a position of responsibility in government, or private industry, or a profession. Thus the course is for executives in private business and in government and members of the legal, educational, medical, scientific, and other professions.

More than 4800 executives have graduated from the correspondence course and present completions are at the rate of more than 900 a year.

The Emergency Management course is presented in an introductory volume and five units as follows:

Volume 1. The Nature of Economic Mobilization

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6. Natural Resources
7. Energy Resources
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Unit V. MANAGING THE EMERGENCY ECONOMY
Volume 19. Administration of Mobilization of WW II
20. Economic Stabilization
21. Reconversion and Partial Mobilization
22. Retrospect and Prospect

Procedures

There is no registration nor tuition fee. Texts and materials are furnished by the Industrial College of the Armed Forces. Graduates may retain the texts for their own libraries but applicants who do not complete the course are asked to return all materials.

Students who are able to devote full time to the work can complete the course in less than six months. Most graduates take about one year and some have taken more than two years to complete the course. Suggested time for each part of the course is:

Part	*Title*	*Weeks*
Introduction		2
Unit 1.	Background	7
II.	Resources and Facilities	12
III.	Mobilization of Resources	9
IV.	Foreign Relations	9
V.	Managing the Emergency Economy	12
	TOTAL	51

If the student is unable to maintain this schedule, the College will grant reasonable extensions of time on request. A student who fails to complete a unit within a reasonable time will be dropped from the course.

Two examinations are required for each part of the course. The first is a practice exercise and learning aid which also tells the student how well he is doing. The second is for record.

Questions, comments, and recommendations are welcomed at any time on any part of the course. An advisor will answer all communications.

The Industrial College has been charged by the Joint Chiefs of Staff to provide this correspondence course in order to help further prepare governmental and private executives as managers of national readiness for emergencies.

A Certificate of Completion is awarded to everyone who satisfactorily accomplishes the course. The Certificate is suitable for framing and is forwarded through any supervisory person who may be named by the graduating student.

The petroleum industry needs more than any other to be thoroughly grounded in emergency management. If you are interested you can get more information by writing: The Commandant, Industrial College of the Armed Forces, Fort Lesley J. McNair, Washington 25, D.C., Attn: Correspondence Study Branch. ★ ★ ★

"Turning Point Reached" — *First Half Reports*

Ernestine Adams

ACTUAL DEMAND for petroleum products in 1958 was up from 1957 but it was harder to make any profit, six months reports reveal. (Table at right.)

In 1958 revenues were only 3 percent down for the first half for 66 companies but earnings dropped 35 percent. Earnings were 14.9 percent of gross income in the first half of 1957 compared to 10.9 percent for 1958.

Despite these figures, the petroleum industry's six months reports look forward cheerfully to the last half.

In a letter to shareholders, W. K. Whiteford, Gulf Oil president, said, "The second half of 1958 should produce higher operations than the first half because of general business conditions, as well as nearly completed correction of an over-supply situation in the oil industry."

Colorado Oil and Gas president, W. C. Norman, said, "The company looks to considerably improved earnings for the remainder of 1958."

Commenting on the mid-year results, R. G. Follis, Standard of California chairman, thought that "so far as the petroleum industry is concerned there are good indications that the bottom of the economic decline has been reached and an upturn is underway." He mentioned sales, stabilizing market conditions, higher production allowables that had come about in response to improved consumption.

Charles L. Suhr, chairman of South Penn Oil Company, told shareholders "Toward the end of the six-months period an increasing demand developed. This is an encouraging indication that the low point of the recession may have been reached."

In Cosden Petroleum's report, R. L. Tollett, president, stated: "We are observing improvements in even short-term prospects. Higher levels of earnings are in view for the not too distant future."

American Petrofina, only company on our list with a net loss for the first six months, was nevertheless optimistic in its report. Harry A. Jackson, president, said, "As a result of improved conditions, the company's operations in June were profitable and the outlook for the remainder of the year is now most encouraging."

Even in the strange year of 1958 some companies improved their earnings over the high records of 1957. Aztec Oil and Gas Company had a 16 percent increase. President Wofford Cain reported to stockholders that the new deliveries of Paradox Basin oil production to the Four Corners pipeline accounted for the rise in revenues and earnings.

As P. C. Spencer, chairman, stated in the Sinclair report, "It is customary to compare earnings of whatever current period is being reviewed against the similar period of the preceding year, but seldom have two half years been so unlike each other as the first six months of 1957 and 1958."

Demand from Europe in 1957 when it was cut off from normal supply sources by the closing of the Suez, was abnormally high. In 1958 not only did demand slacken, but excessive inventories were left from the industry's successful effort to supply European emergency needs.

Three reasons were named again and again by petroleum companies for the sharp decline in first half revenues and earnings.

1. **Lower crude oil production (in other words, lower demand).**
2. **Depressed prices of products.**
3. **Higher costs.**

"Since the middle of last year the petroleum industry has been faced with the problem of working off excess inventories," Wallace C. Thompson, president of General Crude Oil Company, told stockholders.

A table in the company report showed that allowable producing days in Texas had been reduced by 40 days over the first six months, which was a 42 percent decline from 1957.

"The decrease in income is due principally to decline in production as a result of lower allowables and a decrease in lease bonuses," stockholders heard from Robert M. Young, president of Louisiana Land and Exploration Company.

Atlantic Refining's production is also largely in Texas. Said Henderson Supplee, Jr., president, "Unfavorable earnings for the first six months were largely the result of unfavorable product prices and fewer allowable crude producing days." Average prices for Atlantic gasolines were 5.8 percent less than in 1957 and heating oil sales prices were down 13.9 percent.

L. A. Cranson, president Honolulu Oil, more specifically named reasons for lower earnings as curtailment of production and "reduced prices on crude, natural gas and natural gas liquids."

In the Phillips' report K. S. Adams, chairman, stated "Lower 1958 first half earnings reflect general conditions in the overall economy as well as in the petroleum industry . . . these conditions have outweighed the encouraging results of our cost-reduction program." The Phillips' report pointed out that its automotive gasoline sales for the second quarter of 1958 were higher than in the same period of last year.

J. R. Parten, president of Woodley Petroleum, commented that net income for the second quarter of 1958 was equal to that of the first quarter; a reduction in gross income because of reduced allowables having been offset by decreases in operating costs and abandonment charge-offs.

William Wallace Mein, Jr., president of Bishop Oil Company, reported that "A severe decrease in production allowables in Canada and Texas was primarily responsible for this year's lower figures."

Clark Oil and Refining recorded an increase in gasoline volume during the first half of 1958. President Emory T. Clark pointed out, however, that "Since prices of all petroleum products remained at a low level through part of the second quarter, the company showed a decrease in dollar value."

Universal Consolidated's president, E. G. Starr blamed their earnings decline on the "impact of economic pressures on the oil industry due to excessive imports of foreign-produced crude and products." He told shareholders the company had been forced to shut in 119 marginal wells and to curtail other production because of imports into California.

Dividends have held up remarkably well and it appears that the third quarter will show no marked change. Not all of the companies have declared dividends for the third quarter yet.

Most promising aspect of the reports is well described by W. Alton Jones of Cities Service. "The industry's basic strength is evidenced by the fact that demand for oil products actually increased during this time when numerous other industries were experiencing sharp declines. This emphasizes that the petroleum industry problems resulted from excessive production."

★ ★ ★

66 PETROLEUM COMPANIES FINANCIAL REPORTS FOR FIRST HALF

(all figures subject to revision)

First Quarter	Gross	1958/57 — 15%	Net	1958/57 — 33%
		1957/56 + 16%		1957/56 + 17%
Second Quarter	Gross	1958/57 — 3%	Net	1958/57 — 35%
		1957/56 + 13%		1957/56 + 13%

($1000)

Company	Second Quarter Gross 1957	Second Quarter Gross 1958	Second Quarter % of 1957	Second Quarter Net 1957	Second Quarter Net 1958	Second Quarter % of 1957	Six Months Gross 1957	Six Months Gross 1958	Six Months % of 1957	Six Months Net 1957	Six Months Net 1958	Six Months % of 1957	Dividend on common stock 6 months 1957	Dividend on common stock 6 months 1958
Amerada	$ 28,758	24,122	84	$ 6,901	$ 4,299	62	$ 61,549	$ 51,072	83	$ 15,647	$ 9,850	63	$1.00	$1.00
American Petrofina[11]	—	—	—	—	—	—	21,725	33,538	154	1,192	(297)	—	3%s	0.10s[1]
Anderson-Prichard	16,914	16,411	97	1,336	718	54	34,678	33,677	97	2,819	1,377	49	0.60	0.60
Argo Oil	3,714	2,875	77	1,033	884	86	7,508	6,242	83	2,822	2,421	86	0.50	0.50
Ashland O & R	79,306	63,332	80	3,656	1,315	36	159,397	—	—	8,575	—	—	—	—
Atlantic	132,401	119,616	90	10,561	4,972	47	302,047	264,427	88	25,322	7,667	30	1.00	1.00
Aztec	—	—	—	—	—	—	1,338	1,583	118	509	591	116	None	Stock
Bishop	640	580	91	42	19	45	1,320	1,115	84	144	46	32	0.10	0.10
British American[11]	—	—	—	—	—	—	—	—	—	12,660	6,142	49	0.50	0.50
Champlin O & R	20,402	19,133	94	2,175	1,563	72	41,255	37,743	91	4,484[13]	2,865	64	0.50	0.50
Cities Service	241,066	231,424	96	12,888	11,114[2]	86	547,555	518,709	95	36,315	24,618[2]	68	1.20	1.20
Clark O & R	17,279	16,991	98	220	63	29	36,302	34,656	95	692	222	32	4%s	4%s
Colorado O & G	8,328	7,878	95	764	265	35	16,082	15,932	99	1,454	595	41	None	None
Continental	151,457	141,906	94	10,074	9,509	94	306,830	283,649	93	23,714	20,208	85	80	80
Crescent Corp.	—	—	—	—	—	—	—	—	—	—	146	—	—	—
Delhi-Taylor	18,176	15,298	84	2,426	(468)	—	35,786	32,171	90	4,103	(714)	—	77	[14]
Drilling & Exp.[11]	—	—	—	—	—	—	21,136	18,928	90	538	306	57	0.12½	0.12½
Eason Oil[3]	1,029	962	93	128	170	133	2,117	2,205	104	379	422	111	0.25	0.25
Felmont Pet.[5]	2,614	2,413	92	818	227	28	5,156	4,779	93	1,678	942	56	St.	St.
Fifteen Oil	—	—	—	—	—	—	1,587	1,215	77	633	102	16	0.15	0.15
General American	7,089	5,751	81	2,561	814	32	13,938	11,591	83	5,091	2,474	49	0.30s	0.35
General Crude	—	—	—	—	—	—	7,578	6,448	72	2,085	1,139	55	0.50	0.50
Getty	—	—	—	—	—	—	—	—	—	12,962	7,980	61	St.	St.
Gulf Oil	—	—	—	76,131[7]	55,069	72	1,383,554	1,302,263	94	171,069[7]	115,737	68	1.25	1.25
Hancock	12,772	12,081	95	1,874	1,527	81	28,082	25,222	90	3,835	3,310	86	0.30s	0.30s
Honolulu	11,786	9,346	79	3,773	2,187	58	23,697	19,909	84	7,616	5,586	73	1.00	1.00
Kerr-McGee	—	—	—	—	—	—	—	—	—	—	—	—	0.40	0.40
Leonard Refineries	10,861	12,178	112	415	283	68	26,925	23,821	88	1,014	742	73	0.50	0.40
Louisiana Ld. & Exp.	9,294	7,339	80	5,032	4,061	81	18,733	16,048	86	10,503	8,861	84	0.60	0.70
Macmillan	—	—	—	—	—	—	6,840	7,777	114	27	(120)	—	—	—
Maracaibo Oil Exp.	580	455	78	130	48	37	1,192	935	78	293[3]	139	47	0.20	0.15
Midwest Oil	4,846	4,481	92	1,510	1,472	97	9,806	9,155	93	3,612	3,347	93	0.70	0.70
Monterey[4]	6,178	5,054	82	776	599	77	11,946	10,986	92	1,496	1,358	91	0.40	0
Ohio Oil	68,425	61,544	90	9,567	6,719	70	146,938	133,406	91	22,233	15,087	68	0.80	0.80
Olin O & G	—	—	—	—	—	—	15,109	17,506	116	757	922	122	None	None
Phillips	276,707	250,706	91	25,019	15,995	64	572,811	512,433	89	53,399	36,412	68	0.85	0.85
Plymouth	30,082	19,516	65	1,886	650	34	62,760	43,197	69	4,405	1,520	35	0.80	0.60
Pure Oil	126,566	114,574	91	8,842	5,943	67	260,773	237,443	91	19,012	10,675	56	0.80	0.80
Quaker State	12,537	11,761	93	588	522	88	26,473	24,228	91	958	811	84	1.00	1.00
Richfield Oil	64,586	62,314	96	6,666	4,805	72	134,230	123,288	92	13,705	10,410	76	1.50	1.50
Shamrock O & G	14,207	13,986	98	1,958	2,038	104	28,800	27,971	97	4,820	4,713	102	0.67[5]	0.80
Shell	437,791	394,120	90	33,871	19,182	57	906,969	804,267	89	75,321	45,652	61	1.00	1.00
Signal O & G	6,151	6,256	102	2,960	2,760	93	12,547	12,210	97	6,136	5,660	92	0.40	0.40
Sinclair	297,650	268,470	90	18,546	8,399	45	645,946	592,474	92	44,848	24,807	55	1.50	1.50
Skelly Oil	64,211	58,838	92	8,545	4,535	53	132,428	122,404	92	19,934	10,549	53	0.90	0.90
Socony Mobil	—	—	—	59,100	28,400	48	1,506,613	—	—	126,800	67,500	53	1.00	1.00
South Penn Oil[11]	—	—	—	—	—	—	29,850	26,517	89	3,127	1,630	52	1.00	1.00
Standard Calif.	437,721	416,330	95	66,856	59,325	89	869,832	808,183	93	136,329	116,735	86	1.00	1.00
Standard Ind.	493,897	432,989	88	36,726	20,991	57	1,049,465	911,511	88	82,577	52,423	63	1.00	1.00
Standard N. J.[15]	1,987,000	2,140,000	108	226,000	124,000	55	4,030,000	3,720,000	92	463,000	291,000	63	1.10	1.10
Standard Ohio	106,083	93,918	89	4,782	7,117	149	217,667	191,457	88	12,623	11,436	91	1.25	1.25
Sun Oil	192,497	166,061	86	11,856	7,986	67	400,921	334,671	83	25,187	11,560	46	0.50	0.50
Sunray Mid-Con.	90,230	82,229	91	11,799	8,710	74	181,035	165,192	91	24,835	19,251	78	0.66	0.66
Superior[4]	28,867	27,647	96	6,166	5,028	82	55,001	54,231	99	10,500	8,800	84	0	0
Texas Co.	—	—	—	78,722	68,532	87	—	—	—	165,146	138,536	84	1.00	1.00
Texas Gulf	4,913	3,665	75	1,786	452	25	9,662	7,875	82	3,666	1,617	44	0.30	0.30
Texas Pacific C & O	6,398	4,959	78	1,881	857	46	12,993	10,800	83	3,950	2,353	60	0.50	0.50
Tidewater	154,171	132,089	86	10,090	(524)	—	312,885	266,366	85	21,569	279	1	St.	St.
TXL Oil	3,163	2,544	79	1,381	651	47	5,908	5,470	93	2,396	1,593	66	None	None
Union of Calif.	111,268	104,087	94	7,400	5,462	74	219,028	201,035	92	16,727	11,457	68	1.20	0.85s
Union O & G of La.	7,806	7,925	102	1,657	1,875	113	16,637	16,637	100	3,368	4,091	121	0.80	0.80
Universal Consol.	2,203	2,193	99	946	641	68	4,396	4,378	99	1,927	1,123	58	1.30	1.30
White Eagle	3,002	2,955	98	168	150	89	5,602	5,541	99	418	252	60	10%s	5%s
Wilcox	1,992	1,396	70	281	180	64	4,756	3,790	80	534	369	69	0.50s[6]	0.50s[6]
Woodley	1,869	1,732	93	899	641	71	3,792	3,675	97	1,749	1,281	73	0.25s	0.25s
TOTALS	$5,225,075	$5,091,849	97	$748,608	$489,127	65	$12,302,236	$11,234,351	91	$1,641,539	$1,084,682	66	$35.45½	$34.73½

( ) Loss.
S or St: Stock dividend.
[1] Plus 2½% stock dividend.
[2] Includes capital gain of $6,551,000.
[3] Not including capital gain of $408,106.
[4] Period ended May 31.
[5] Adjusted for stock split.
[6] 2½% stock dividend each year.
[7] Excludes capital gain of $30,686,000.
[8] Formerly American Maracaibo Co.
[9] Nine months ending April 30.
[10] First six months and quarter based on fiscal year ending September 30.
[11] Reports only semi-annually and annually.
[12] Second quarter figures are our estimate from Jersey's first quarter and six-month releases.
[13] Excludes capital gain of $858,000.
[14] Rights to buy Houston Corp. shares.

How Can We Improve Our Public Relations?

Condon MacKay

A FEW WEEKS ago in Chicago I heard the slogan of the Society of Missile Watchers: "Be active today or be radioactive tomorrow." It might well be ours.

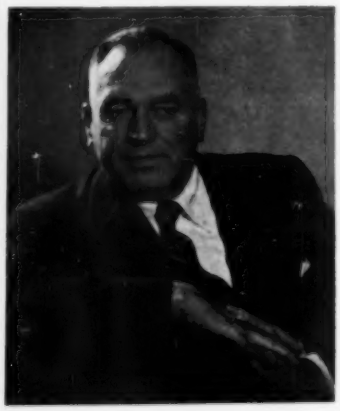
Like you I am proud of the unparalleled achievements of this industry in serving our nation. These achievements are truly tremendous.

Prices Reasonable

First, let's look at prices.

Average price today is 21.8 cents for a gallon of regular gasoline before state and federal taxes. The average price last year was 22.1 cents and this included the first general crude oil price increase in nine years.

Ten years ago, the price was 19.5 cents. In 10 years, a price increase of only 13.3 percent.



Condon MacKay is manager, public relations department, The Carter Oil Company, Tulsa. With Carter 20 years, he has served in various capacities such as land department manager, employee relations manager, and as assistant to the president. He has worked extensively in the various phases of the oil industry public relations program. He has been active in community affairs, serving two years as president of the Tulsa Council, Boy Scouts of America, and as a member of the board of the Tulsa Community Chest.

Quality Higher

What can you say about product quality?

When the American motorist goes into a service station today, he gets 91.1 octane regular gasoline. In 1948 the octane number of regular gasoline was 80.8. If you buy premium gas today you get 98.5 octane. Today's regular gasoline is better than aviation gas just a few years ago. There has been similar improvement in other products.

Supply Ample

In peace and war the oil industry has supplied the nation's needs.

Last year, the United States oil industry produced an average of 7,175,000 bbl of crude daily.

In 1948, the daily average crude output was 5,520,000 bbl.

This means that in the last 10 years, the oil industry has increased its producing rate 1,655,000 bbl daily.

With oil pools increasingly difficult to find, with discoveries diminishing in size, with drilling depths increasing and costs mounting, this production increase is a modern day industrial miracle.

Domestic natural gas marketed last year was 10.6 trillion cu ft, more than double production 10 years ago. This has been another spectacular accomplishment of the industry, but further progress will be hampered if there is a continuation by the Federal Power Commission of regulation on a utility basis. Latest gas use figures show 27.7 million residential consumers compared to 21.2 million in 1949 — an increase of 6½ million residential consumers in the last 10 years.

This paper was presented at Rocky Mountain District, Division of Production, American Petroleum Institute, Denver, Colorado, April 22, 1958.

Good Employee Relations

According to the latest figures of the Bureau of Labor (November 1957) the average weekly earnings of oil and gas production workers are $108.41, and for oil refining average weekly earnings are $115.30. These compare with $82.92 for all manufacturing.

Furthermore, from the last report of the Economic Research Department of the United States Chamber of Commerce, employee benefit payments in the oil industry are 25 percent more than in all manufacturing.

Public Does Not Know

Yet, with all these achievements, the industry undergoes a barrage of charges from uninformed and sometimes bitter people.

These charges are a major cause of the public relations difficulties the oil industry faces today.

If you want to improve the public relations of this industry, answer these charges. Answer every charge, in every locality, from every source. Answer them every time they are made.

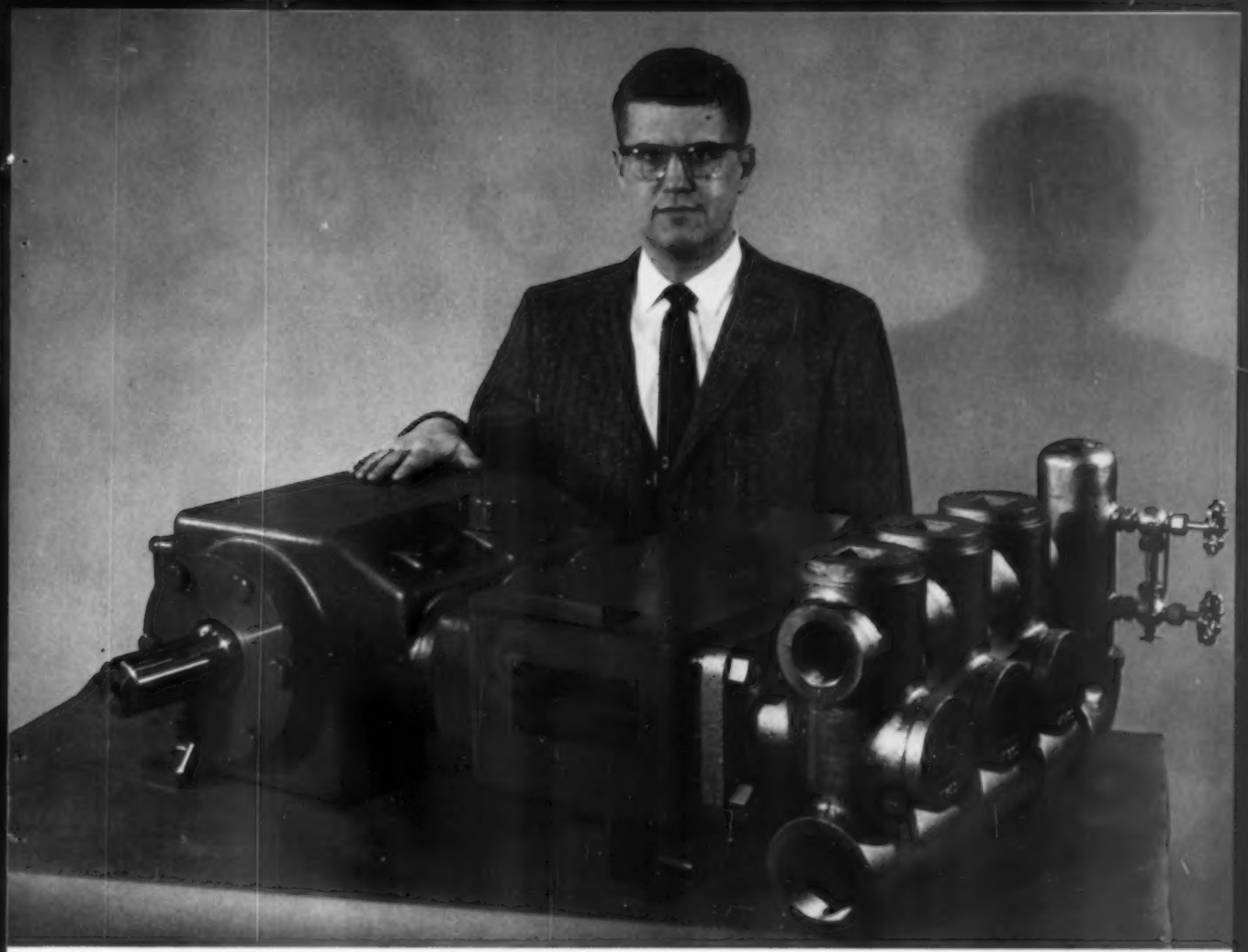
Failing to answer charges has prevented the industry from enjoying justly deserved good relations with the public.

When we start showing the public these charges are not based on fact, and are made by uninformed, or, on occasion, by irresponsible people, the charges will lose their effect. Moreover, these people will think twice before making misstatements of fact or unfounded accusations.

Responsibility Is Ours

This responsibility you and I must not evade.

The industry has readily available all the facts and information with which to combat these misrepresentations. Get these materials and be prepared to



NEW WATERFLOOD PUMP

Worthington KCA pump offers you highest displacement, most pressure, low cost

The new KCA waterflood and salt water disposal pump has just been introduced by Worthington. This new pump has the highest displacement of all comparable competitive models—fully 23% more barrels per day. It also delivers the most pressure. And it's priced at only $38 per input horsepower.

The KCA has 6 outstanding economy and efficiency features:

1. Interchangeable plungers over widest available diameter range (1¼ to 2½ inches). Permits changes within any stuffing box range without changing fluid end. Available as ceramic or hardened stainless steel.

2. Straight-flow design for maximum volumetric efficiency.

3. Maximum stuffing box accessibility. There are no partitions in power end cradle.

4. Suction air chamber, packing and stuffing box cover are standard equipment.

5. Large pipe connections, 3 inch suction, 2 inch discharge on either side.

6. Wing-guided valves, liberally sized suction and discharge valves both removable through single top cover.

For details, see your Worthington district office. Or write: Worthington Corporation, Section 32-1, Harrison, N. J.

WORTHINGTON

HIGHEST DISPLACEMENT

Worthington KCA	2300
Brand A	1860
Brand B	1590
Brand C	1300
Brand D	1055

MAXIMUM DISPLACEMENT IN BARRELS PER DAY*

*At normal ratings. Some manufacturers, including Worthington, will permit higher speeds, capacity and horsepower after approving suction conditions. Best performance, however, is obtained by staying within normal ratings.

MOST PRESSURE

Worthington KCA	3100
Brand A	3000
Brand B	3050
Brand C	1490
Brand D	1550

MAXIMUM PRESSURE—PSI

LOW COST

Worthington KCA	$38
Brand A	35
Brand B	46
Brand C	58
Brand D	47

COST PER INPUT HORSEPOWER—NORMAL RATINGS

C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

Insure safe, more effective lubrication protection for *your* compressor units. Specify Gulf Security . . . the high quality, straight mineral oil. For full information, call your nearest Gulf office.

GULF®

GULF OIL CORPORATION, Dept. DM, Gulf Building, Pittsburgh 30, Pa.

HERE ARE SOME SPECIFIC ANSWERS

Answer on Depletion Deduction

When some misguided critic attacks the percentage depletion provision, let's answer, pointing out to the public:

1. The oil industry is bearing its full responsibility in paying taxes. The Statistics of Income published by the Treasury Department show that income taxes paid by petroleum producers represent 7.2 percent of their gross revenue, compared with about 5.0 percent for manufacturing corporations, and 3.9 percent for all industry.

2. Percentage depletion is no loophole as political label-smearers call it.

An oil property is a capital asset and the oil-production business is primarily that of selling a capital asset — and Congress has decreed that only one-half of the gain from the sale of a capital asset held more than six months shall be taxed.

This is not a special provision for any special interest. It is a general provision which applies to every individual, including oil men. Congress has said, in effect, that if a farmer sells his farm at a profit, then he should be taxed on only one-half that profit. In exactly the same way, the owner of an oil property is taxed on only one-half of the profit he would realize from the bulk sale of the whole property.

Now, it is difficult to see any substantial difference between a sale involving all of the oil in place and the sale of the same oil a barrel at a time, but the Internal Revenue Code does make a distinction and treats them differently.

It tells the oil men, in effect: "If you sell all of the oil in place, you may deduct 50 percent of the profit and pay tax on the remainder. However, if you produce this oil and sell it on top of the ground, then you may deduct only 27.5 percent of the gross selling price, but still not more than the 50 percent of net profit which is allowed for a capital sale."

Let's make it clear that different taxpayers all have different provisions in making tax returns: Provisions for dependents, provisions for interest payments, medical expense. Further, that different businesses must be taxed differently: That life insurance companies, banks, oil, and mining companies all have different tax provisions, yet pay their fair share of the taxes. Percentage depletion for oil producers is a different, not a "special," provision.

3. Only the percentage depletion provision could have been so effective in making available the record daily average production of 7,175,000 bbl per day. But the industry in the future is confronted with a task of even greater magnitude: Supplying a demand 10 years from now of 15,000,000 bbl daily. To impair the effectiveness of the depletion provision now would be to jeopardize the ability of the industry to meet the nation's tremendously increasing demands in the years ahead.

Answer on Gas Utility Pricing

When we hear demands for natural gas production price regulation, let's defy the people making these demands to show how, in any way, the production of natural gas is a public utility function. It is no more a public utility function than production of any other raw materials such as oil, coal, copper, or iron.

Again and again point out that the producer gets only 10 cents of each dollar paid by the household consumer of natural gas, and that the balance, 90 cents, is determined by utility commissions regulating the franchises under which the natural gas is transported and sold.

Answer to Oil Prices and Profits

Let's consider charges made relative to oil prices and profits.

Few people realize the almost astronomical quantities of petroleum products required to meet demand. This is where the uninformed or devious critics mislead the public about oil industry earnings. They point to the total size of earnings without reference to quantity. They mention the *sum* of earnings without reference to the ratio to sales, or rate of return on the amount of money invested.

When these people cry excessive oil industry profits and high prices, let's answer them with facts to show the public that earnings of the domestic oil industry are not excessive in comparison with other industry. To be specific: In 1956, the last available statistics, domestic oil companies had a rate of return on net worth of 12.7 percent compared to a return for all domestic manufacturing industry of 13.9 percent. Including foreign oil operations with all their risks, total oil industry returns were 8/10 of one percent higher than domestic manufacturing industry returns.

When we hear charges of unwarranted prices, let's cite government statistics which are available to everyone. These demonstrate that year after year prices of petroleum products have risen less than the average price of other commodities.

Latest Bureau of Labor figures show that the price index of petroleum products is 118.2 with reference to the 1947-49 base, while the price index of all commodities, excluding farm products and food, is 125.2. This index is the one normally used by economists for such comparison. However, including farm products and food, the index for all commodities is still 118.9 compared to petroleum's 118.2.

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stop these unwarranted and damaging attacks. Be specific, don't talk in generalities.

Build Understanding

But let's don't sit back and wait for attacks.

Let's do our best to constantly build understanding with the public so that we can reduce attacks and make then ineffectual.

Let me say parenthetically that we can't expect the best public relations program on earth to prevent every attack. Let's realize this and not say the next time we have someone attack us that our public relations are all gone to pot again.

What is public relations, anyway?

Public relations is reporting and explaining to the public continually your actions and policies so that the public can readily identify these actions and policies with its interest.

As I said, let's don't sit back and wait for the attack — let's go ahead and pursue a steady program of building public understanding.

How?

1. By information to the press.
2. By industry publications.
3. By public relations advertising.
4. By speeches.
5. By tours and open houses.
6. By personal contacts with legislators, government officials, editors and others who influence public action — establish a relationship of understanding with these people.

These are all sound public relations activities which will benefit the industry.

To get the most out of these activi-

THE MODERN TAPE COATING THAT'S CHANGING THE FACE OF YOUR INDUSTRY

WHEREVER THEY LEAD, THE NATION'S PIPELINES CAN NOW BE CONSTRUCTED FASTER...EASIER...WITH REAL SAVINGS, USING THIS TIME-TESTED POLYETHYLENE TAPE BY POLYKEN

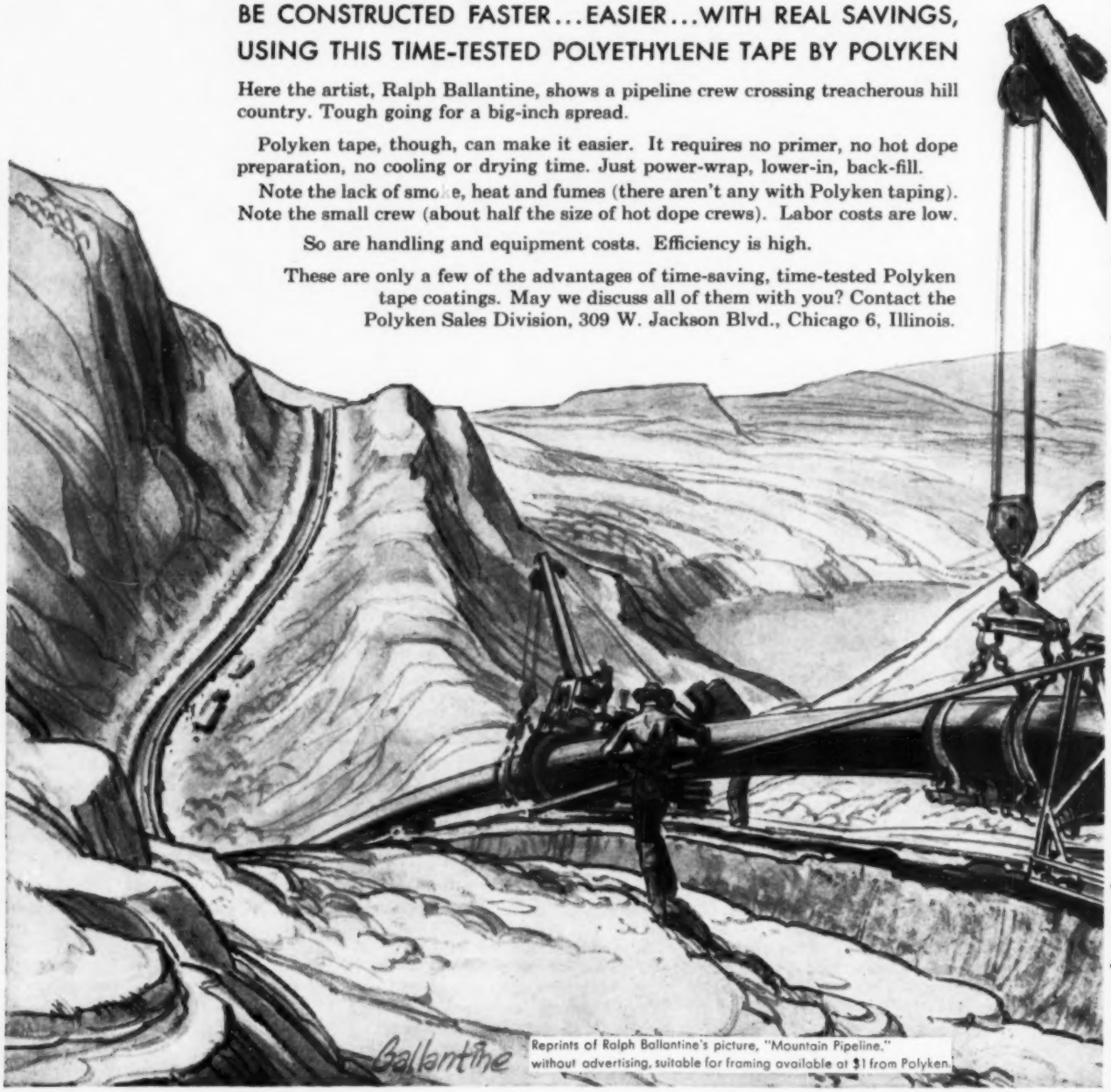
Here the artist, Ralph Ballantine, shows a pipeline crew crossing treacherous hill country. Tough going for a big-inch spread.

Polyken tape, though, can make it easier. It requires no primer, no hot dope preparation, no cooling or drying time. Just power-wrap, lower-in, back-fill.

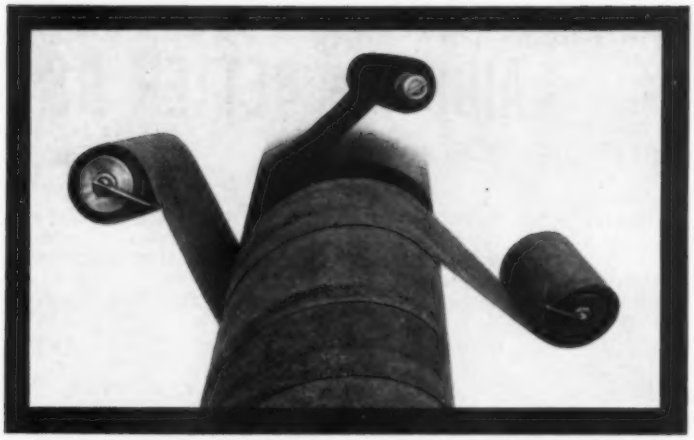
Note the lack of smoke, heat and fumes (there aren't any with Polyken taping). Note the small crew (about half the size of hot dope crews). Labor costs are low.

So are handling and equipment costs. Efficiency is high.

These are only a few of the advantages of time-saving, time-tested Polyken tape coatings. May we discuss all of them with you? Contact the Polyken Sales Division, 309 W. Jackson Blvd., Chicago 6, Illinois.



Reprints of Ralph Ballantine's picture, "Mountain Pipeline," without advertising, suitable for framing available at $1 from Polyken.



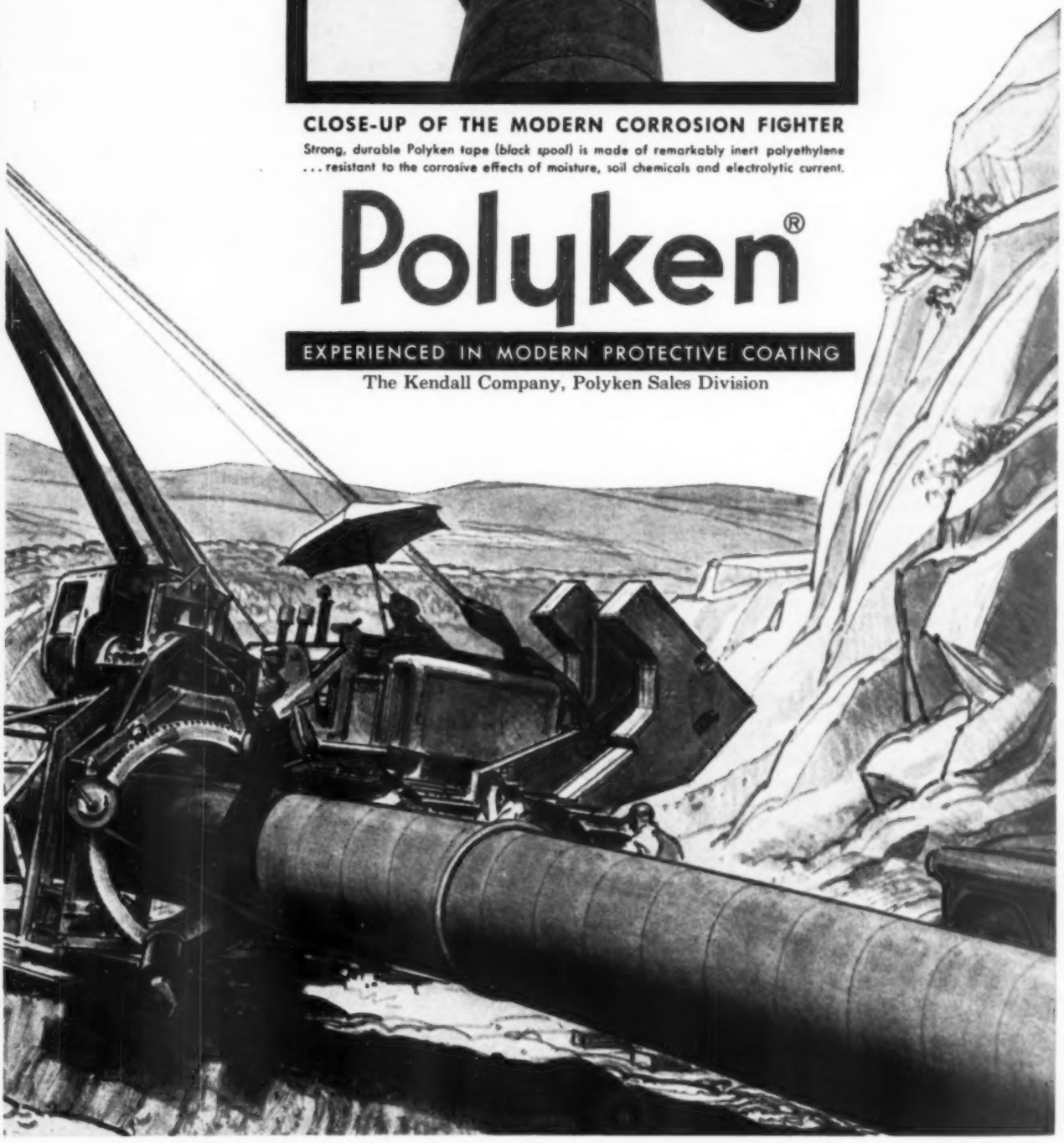
CLOSE-UP OF THE MODERN CORROSION FIGHTER

Strong, durable Polyken tape (*black spool*) is made of remarkably inert polyethylene ... resistant to the corrosive effects of moisture, soil chemicals and electrolytic current.

Polyken®

EXPERIENCED IN MODERN PROTECTIVE COATING

The Kendall Company, Polyken Sales Division



ties, let's talk about prices, profits, percentage depletion, wages and benefits, dealer policies and problems, taxes, natural gas regulation, and other current issues affecting the industry.

But beyond all these, today there are certain matters of great urgency which should demand our immediate attention.

These are three in number, specifically:

First, the American Petroleum Institute should resume its national advertising in the *Saturday Evening Post, Life* and *Look,* and *U. S. News.* If we are to get facts to the public we must put the facts in what the public reads. By means of this national advertising program we must continually report to the public what this industry does in insuring adequate supplies, in maintaining low prices, and improving products. This national advertising is a vital necessity, and differences of opinion as to what form the messages should take must be resolved. It is an effective way for the industry to build public understanding. It's only because of the overwhelming cost, of course, that extending advertising to newspapers has not been feasible. In the future perhaps something can be worked out in this regard.

Second, a spokesman should be established for the industry on the national level.* This spokesman must be in a position to speak out promptly and with authority. Too often it is weeks before the industry tells the public of its position on some important issue. The time to answer charges is the day they are made. The wire services want both sides of any controversial issue. They'll carry the oil industry's refutation in the same story with the charges if the industry has someone who can speak with authority. But he must be readily accessible and willing to speak up. News is a perishable commodity. Delay of a few days or a few weeks will relegate your refutation to a buried position on the inside pages or the box where they throw unused type.

Third, you and I should assume our individual responsibility in answering every single attack against the industry that comes to our attention. We just can't take the chance of depending on anyone else if the job is to be done — it's got to be you and me. It's the certainty that they're going to be answered that will stop irresponsible attackers. Let's fight misrepresentation wherever and whenever we find it.

These things cannot help having a powerful effect in improving our public relations. ★ ★ ★

*The appointment by API of Frank Dennis to the Washington post came after this paper was given but the point Mr. MacKay makes is important.

AIDS for BETTER R&D REPORTS

Survey shows communications between top management and research and development scientists needs improvement to realize full value of department

TOP BUSINESS EXECUTIVES feel that the research and development report should present more meaningful conclusions, more stress on implications of results and more attention to dollar and marketing value of findings.

Based upon results of a nationwide survey of some 500 company presidents and executive vice presidents, *only one out of seven respondents found research and development laboratory reports generally satisfactory.*

The study was conducted as a public service by the Scientific Apparatus Makers Association.

Present Routine

Survey respondents were about even in reporting the use of one research report for all major operating department heads in sales, finance, advertising, etc., in contrast to variations of one report prepared especially for various company division executives.

About one-half of the top management people indicate that research reports to key operating executives are always written, while about a third of them use oral presentation of one kind or another. Relatively few companies employ a combination of written and oral reports to the "front office."

Significant R&D findings are verbally reported to top management, in 9 out of 10 cases. In some instances, these verbal reports are later confirmed by written reports.

Most of the respondents indicate that some specific improvements can be made in the research and development laboratory reports, particularly better interpretation of research findings from management viewpoint.

Three ways suggested most frequently include:

1. *More meaningful conclusions.*
2. *More stress on far reaching implications of results.*
3. *More attention to dollar and marketing value of findings.*

Other ways for improving communication include:

4. *More frequent reports.*
5. *Improvement in quality of reporting.*
6. *More discussions, study groups, and meetings.*
7. *Establishing special group to study communication problems.*
8. *Improvement in reporting laboratory findings.*

Suggestions

One railroad company officer suggests seminar type presentations of significant aspects of R&D results using scale models and other props to assist in presenting the latest laboratory developments.

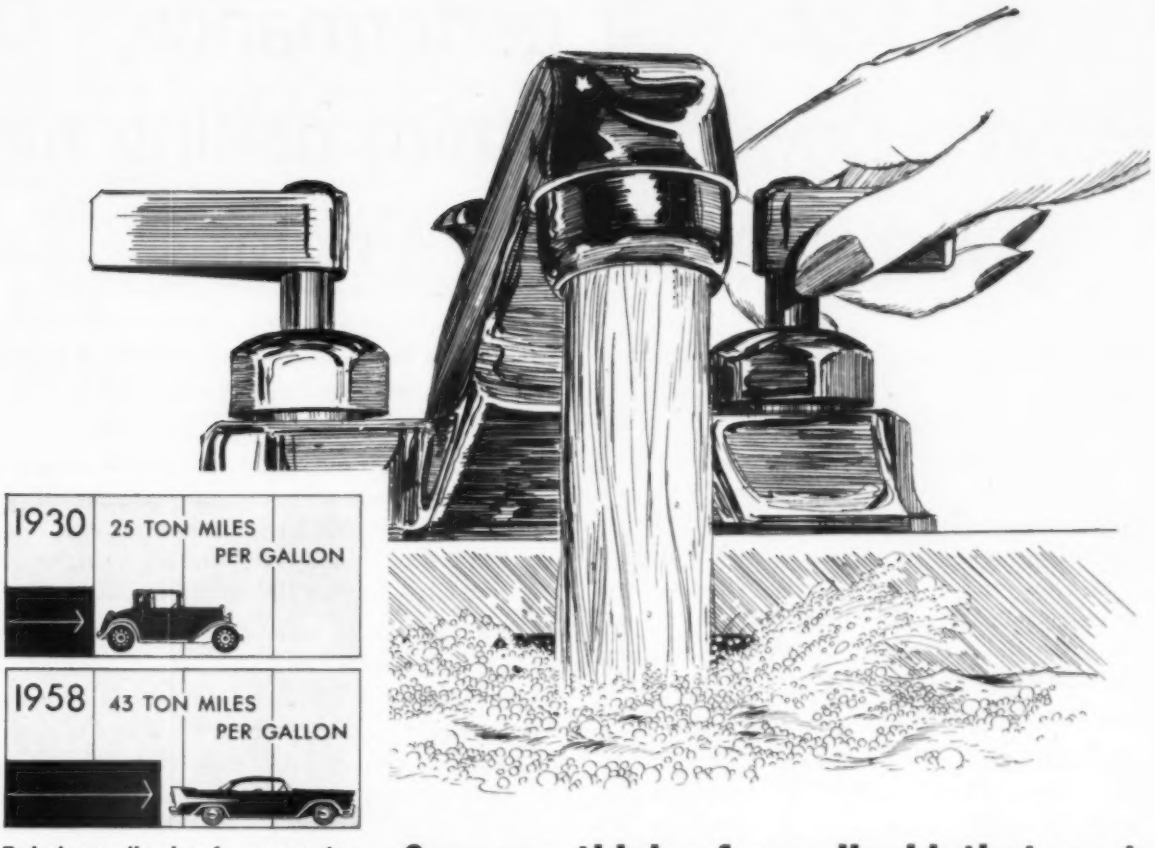
"If there is a fundamental problem in communications it may be that management needs to improve its communications with scientists and we are working on that," says one executive.

"If our scientific staff understands our management policies, we believe their reports will be made to implement our policies as much as possible," he concluded.

A chemical company executive specifically stresses more personal contact between top management and research personnel. He states, "In our organization there has been a trend toward separation of management from the working research man. Efforts are being made to reverse this trend."

Another manufacturer points out that oral reporting dates on laboratory progress should be definitely fixed and used by research personnel and management. Written reports do not usually present the opportunity for management to philosophize or pass "front office" viewpoints on the R&D personnel.

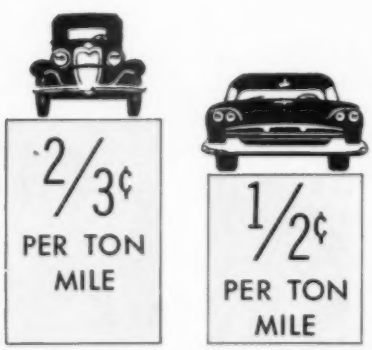
Copies of the apparatus makers' survey findings on improved communications between research laboratory personnel and top management are available without charge. Address: Research Reports, Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, Illinois. ★ ★ ★



Today's gasoline has far more value. An accurate way to measure this value is by "ton-miles"... the number of miles a gallon of gasoline will move a ton of car. Average performance in 1930 was 25 ton-miles per gallon. Today it's 43 — or 70% more work per gallon.

Can you think of any liquid that costs less than gasoline . . . except water?

Quart for quart, gallon for gallon, almost any liquid you buy costs more than gasoline . . . and gasoline performance today costs less than it did in 1930.



Fuel cost per ton mile is down 18% since 1930. To move a ton of car a mile took ⅔¢ worth of fuel. Modern gasolines move today's heavier cars a ton-mile for about ½¢. When you remember you are buying performance, gasoline costs less today than in 1930.

In spite of higher operating costs in the oil industry, gasoline prices have been held down through research and intense competition. Since 1930 the price of gasoline (excluding taxes) rose only 23%. During the same period the general cost of living went up 70%.

The taxes on a tankful of gasoline would buy between four and five extra "tax-free" gallons. Combined state and federal taxes, which help pay for better roads, add about 9¢ to the price of every gallon . . . nearly 30% of your gasoline dollar buys no gasoline at all.

STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

Sold on past performance, Penrod powers its third drilling rig with CAT Diesel Engines

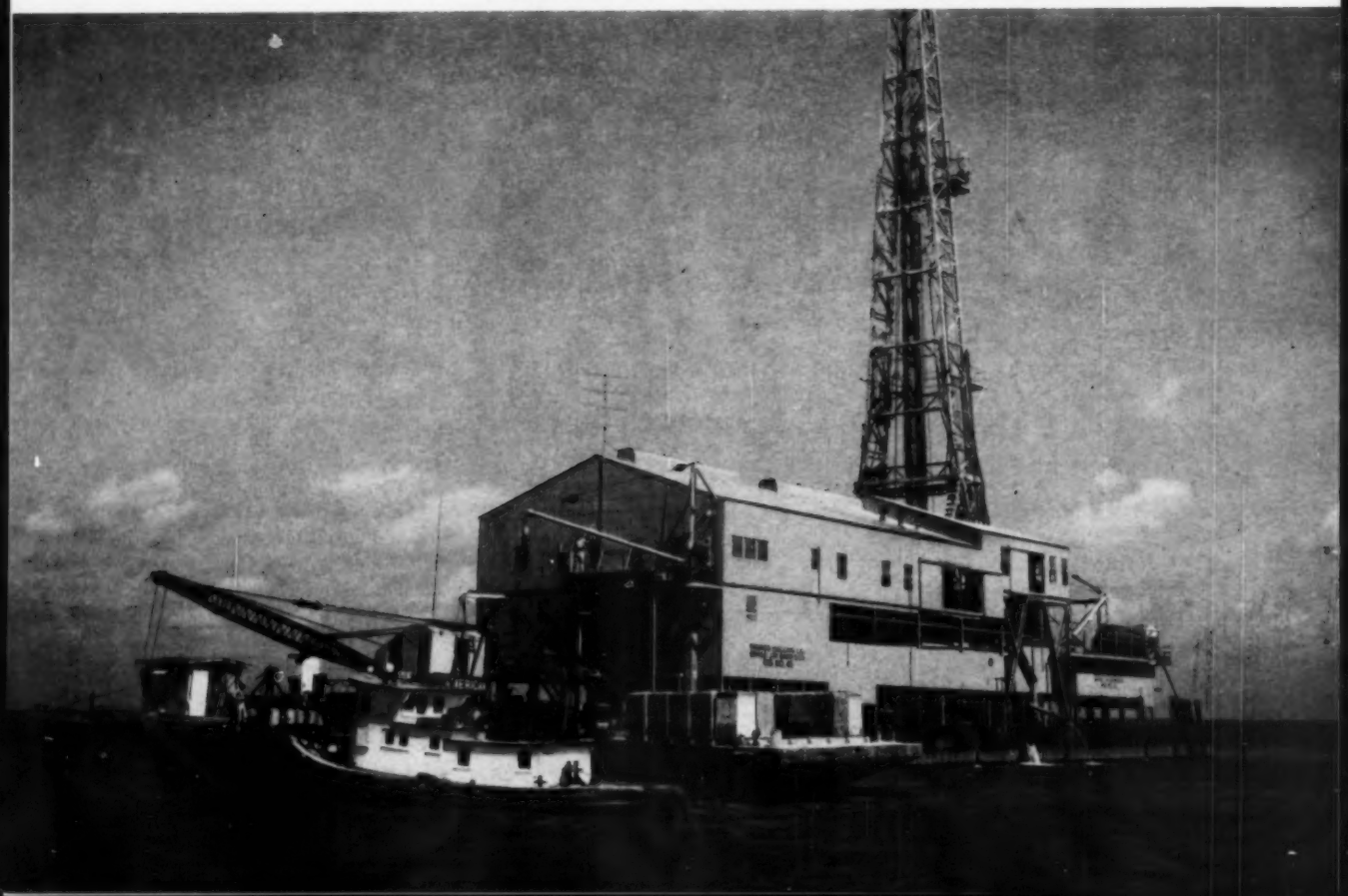
Penrod Drilling Co. of Shreveport, La., working Rig No. 45, fifty miles southwest of Houma in Cat Island Pass (on the southwest edge of Kye Island field) relies on Cat Diesel Engines in drilling better than 1,000 ft. per day. With four D397s, two D315s and two D342s, the "Jim Garrison" barge moved in on Sept. 14, spudded a 15" surface hole and set 3,029 ft. of 10¾" surface pipe. On Oct. 31, they were out of the hole to run electric log at 15,177 ft. and cut a 9⅞" hole on the first well. Their best drilling time was 10,026 ft. in 10 days from spudding date. More than 1,000 ft. per day.

On this offshore drilling operation, Penrod compounds three of its Caterpillar D397 Diesel Engines to drive the Emsco drawworks. Two D315s and a D397 drive water and mud pumps, and two Cat D342 Electric Sets handle auxiliary power.

A big operator and investor in dependable equipment, Penrod can't afford to guess about drilling power. This Company *knows* from experience that Cat Engines are reliably rated and are available in a variety of power sizes for any drilling assignment.

Only two of the many "guts" features which make Cat Engines the best for drilling are cylinder liners and pistons. To give long periods between overhauls, Cat Engine pistons are balanced to close tolerances. Cast-iron bands support the top rings for extra strength, and rings are chrome-faced for

Penrod Drilling Company's "Jim Garrison" Barge, powered by eight Cat Diesel Engines, has drilled at an average rate of 1,000 ft. a day on this job south of Houma, La.



longer wear. Piston rings ride freely with minimum wear because Cat cylinder liners are honed and chemically treated to give long life. Cat wet-type cylinder liners maintain low piston temperatures and are easily changed if necessary.

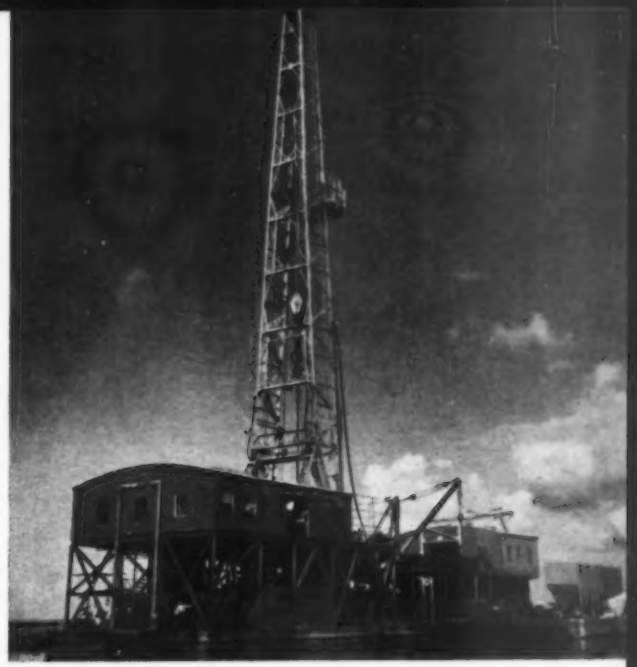
For drilling power—from prime to auxiliary—call your Caterpillar Dealer today. He's that real good neighbor—the one who knows what he's talking about. And be sure to specify Caterpillar power for your drilling equipment.

Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

DURABLE VALVES FOR LONG LIFE

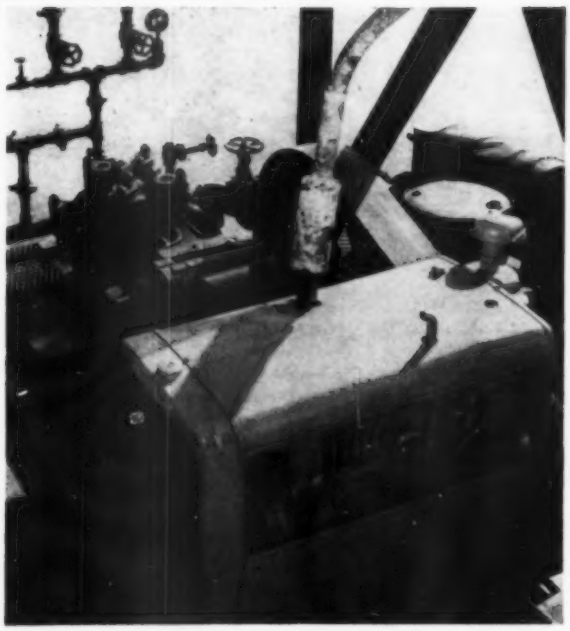
The Cat Engine's valve train features dual valve springs; sodium-filled, alloy steel valves; replaceable valve seats and guides; hardened cam followers; and valve rotators.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

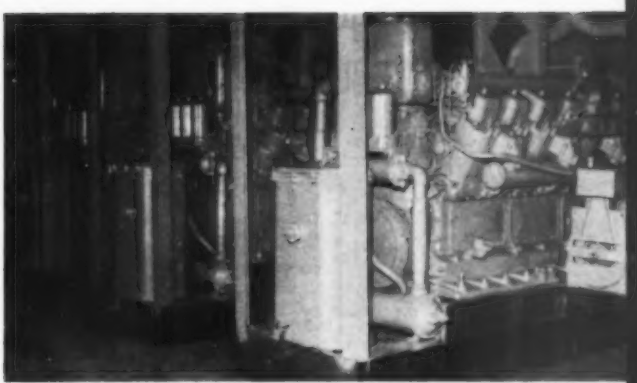


Penrod's Rig No. 41, drilling southeast of Port Sulphur, La., also is powered by Caterpillar. Two D397s are compounded to drive the drawworks, two additional D397s drive the mud pumps, two D315s drive Mission Water pumps, and a third D315 drives a Gardner-Denver water pump, with a Cat D315 Electric Set used for auxiliary power.

ENGINE POWER BY CATERPILLAR



This Caterpillar D315 Engine drives a water pump on Penrod's Rig No. 41 near Port Sulphur, La. One of many components which make Cat Engines dependable is aluminum precision-type bearings supporting the crankshaft. Each bearing has a thin coating of tin for proper bearing break-in for long engine life.



These three Cat D397 Engines are compounded to drive the Emsco drawworks on Penrod's Rig No. 45. Three additional Cat Engines drive the mud pumps and two Caterpillar Diesel Electric Sets furnish auxiliary power for the rig.

Dept. PE9, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Illinois, U. S. A.

Send me more information about Caterpillar Diesel Engines for prime and auxiliary power in drilling operations.

☐ I would like detailed information, as I may be in the market for a Cat Diesel Engine or Electric Set. I understand I am under no obligation.

☐ I am interested in learning more in general about these engines.

Name _____

Company _____

Address _____

City _____ *Zone* _____ *State* _____

Management Personals

Liston F. Hills has been elected a vice president of Aramco Overseas Company, subsidiary of Arabian American Oil Company. Hills succeeds **Ernest K. Schulze,** who is retiring after 38 years in the oil industry, as AOC's vice president and chief engineer. He will continue to make his headquarters in The Hague, the Netherlands, where he has been serving as AOC's assistant chief engineer.

L. F. Hills

G. C. Richardson, Bartlesville, Oklahoma, was elected a director of Cities Service Oil Company (Delaware). Richardson is manager of Cities Service's supply and distribution division.

E. F. Battson, New York City, a vice president, director, and chairman of the executive committee of Continental Oil Company, retired but will continue as a director. Battson also will continue as president of Constock Liquid Methane Corporation and as a director of Continental Carbon Company, both affiliates of Continental Oil.

Glenn E. Guthrie was appointed assistant treasurer and assistant manager of the treasurer's department of the Creole Petroleum Corporation. Before joining Creole, at company headquarters in Caracas, Guthrie was employed by Jersey Standard as senior foreign exchange analyst for Latin America.

R. Paul Henry, financial vice president of Sunray Mid-Continent Oil Company, has also been named treasurer of the company, succeeding the late Louis W. Bennett. **J. Floyd Ladd** is assistant treasurer for Sunray Mid-Continent and **B. P. Lambert** is treasurer of the D-X Sunray company.

David E. Day of Richfield Oil Corporation was elected president of Iricon Agency Ltd., succeeding **S. K. McCauley** of Atlantic Refining Company.

Iricon Agency represents the 5 percent interest in the Iranian Consortium held by American Independent Oil, Atlantic Refining, Getty Oil, Hancock, Richfield Oil, San Jacinto Petroleum, Signal Oil and Gas, Standard of Ohio, and Tidewater.

Two new members have been added to the board of directors of the Shelton-Warren Oil Company. They are **J. B. Duval** and **Mansfield Tweedy,** both of Roswell, New Mexico. Duval is vice president of Shelton-Warren in charge of the firm's new marketing division and Tweedy is founder of Tweedy Oil Company, which was acquired by Shelton-Warren.

Appointees for division vice presidents of the new Committee on Public Affairs, American Petroleum Institute, are: **D. L. Connelly,** Warren Petroleum, (API vice president for production); **H. W. Ferguson,** Humble (API vice president for refining); **D. T. Colley,** Atlantic Refining, (API vice president for marketing) and **C. E. Spahr,** Standard Ohio, (vice president for transportation.

J. G. Jimenez, Tidewater Oil, vice president and Eastern division general manager, replaces **Charles Z. Hardwick,** Ohio Oil's executive vice president and director, who will be unable to serve on the committee because of other commitments.

Completing the membership of the 20-man committee is **S. D. Breitweiser,** vice president in charge of marketing and director of D-X Sunray.

Jack A. Horner was appointed secretary of Shell Chemical Corporation. Horner, who is vice president in charge of the licensing division of Shell Development Company and secretary of Shell Oil Company, succeeds **George E. Brewer,** retired. Horner will retain his posts with Shell Oil and Shell Development.

David T. Searls was elected general counsel of Gulf Oil Corporation. He succeeds **Archie D. Gray,** who was designated a senior vice president. In his new position, Searls will be responsible for all corporate legal matters. Searls is vice president and director of the Almeda State Bank of Houston and director of the Oil Center Tool Company of Houston.

Rawleigh Warner Jr., manager of the economics department, Socony Mobil Oil Company, Inc., was appointed manager of the department of Middle East affairs. He succeeds **Arnold Stebinger,** who assumes a special assignment in connection with the company's overseas operations.

Thomas W. Phelps, assistant to the chairman of the board of directors since 1949, becomes manager of the economics department. **Paul Wollstadt,** who has been associated with the company since 1951, succeeds Phelps.

Dr. Philip C. White was appointed general manager of a new R&D department, Standard Oil Company (Indiana).

In additional changes, **Pike H. Sullivan** was named manager of patents and licensing. Working with Sullivan will be **Arthur G. Gilkes,** appointed general patent attorney, and **Robert Gottschalk,** director of contracts and legal matters.

White was manager of Standard's research department and Sullivan was manager of a development and patent department since 1942. The changes followed the assignment of new responsibilities outside of the research and development field to **Joseph K. Roberts,** former vice president for research and development. Roberts and **John W. Boatwright,** chief economist, will engage in studies connected with the company's activities in the foreign field.

DEATHS

Lester E. Flight, a Sohio Pipe Line Company veteran of 29 years' service, died suddenly in St. Louis, July 18. He was chief dispatcher for 9 years.

E. R. Bonnist, advertising director for The Cooper-Bessemer Corporation for over 35 years, died at his home in Mount Vernon, Ohio, July 6. Death was due to a heart attack at age 62.

Charles F. Dempsey, 51, president of Crosby Valve & Gage Company of Wrentham, Massachusetts, died suddenly July 3.

Milan G. Arthur, 44, of Whittier, California, chief valuation engineer for the Union Oil Company of California, died July 29 while on a business trip to Fresno, California.

Laugh With Barney

A Scot was engaged in an argument with a conductor as to whether the fare was $5.50 or $7.50. Finally, the disgusted conductor picked up the Scotsman's suitcase and tossed it off the train, just as they passed a bridge. It landed with a splash.

"Mon," screamed Sandy, "it isn't enough to try to overcharge me, but now you try to drown my little boy!"

* * *

Returning from a meeting he absently started to tell his wife about the speaker who had, in a lighter moment, offered a silk hat to any man present who could stand up and say he had never kissed another woman since he had been married.

"And would you believe it, Mary — not a man stood up."

"George," said his wife severely, "why didn't you stand up?"

"Well, dear," he replied, after an almost imperceptible hesitation, "I was going to, but you know I look like the devil in a silk hat."

* * *

Frank: What did you do with the blonde you had out last night?

Ernie: Oh, I gave her the air. She turned out to be one of those Iowa girls.

Frank: What do you mean, Iowa girls?

Ernie: You know, I owe a month's rent, etc.

* * *

Joe: "I met my wife in a very funny way — I ran over her in my car and later married her."

Barney: "If everybody had to do that there wouldn't be so much reckless driving."

* * *

Clem: "What's that I hear, Hiram, about your hired man falling off the roof when he was shingling the barn last week?"

Barney: "Yeh, he fell into a barrel of turpentine."

Clem: "Did it hurt him much?"

Barney: "Don't know. They ain't caught him yet."

* * *

He parked the car at the side of the road, but still she wanted to know how far he was going to go.

* * *

Say it with flowers,
Say it with sweets,
Say it with kisses,
Say it with eats,
Say it with jewelry,
Say it with drink,
But always be careful
Not to say it with ink.

* * *

A revivalist said to the congregation: "There is a man among us who is flirting with another man's wife. Unless he puts $5 in the collection box, his name will be read from the pulpit."

When the collection box came in, there were six $5 bills in it, and a $2 bill with a note pinned to it, saying:

"This is all the cash I have, but will send the other $3 Wednesday."

* * *

They call her "Checkers," because she always jumps when you make a bad move.

* * *

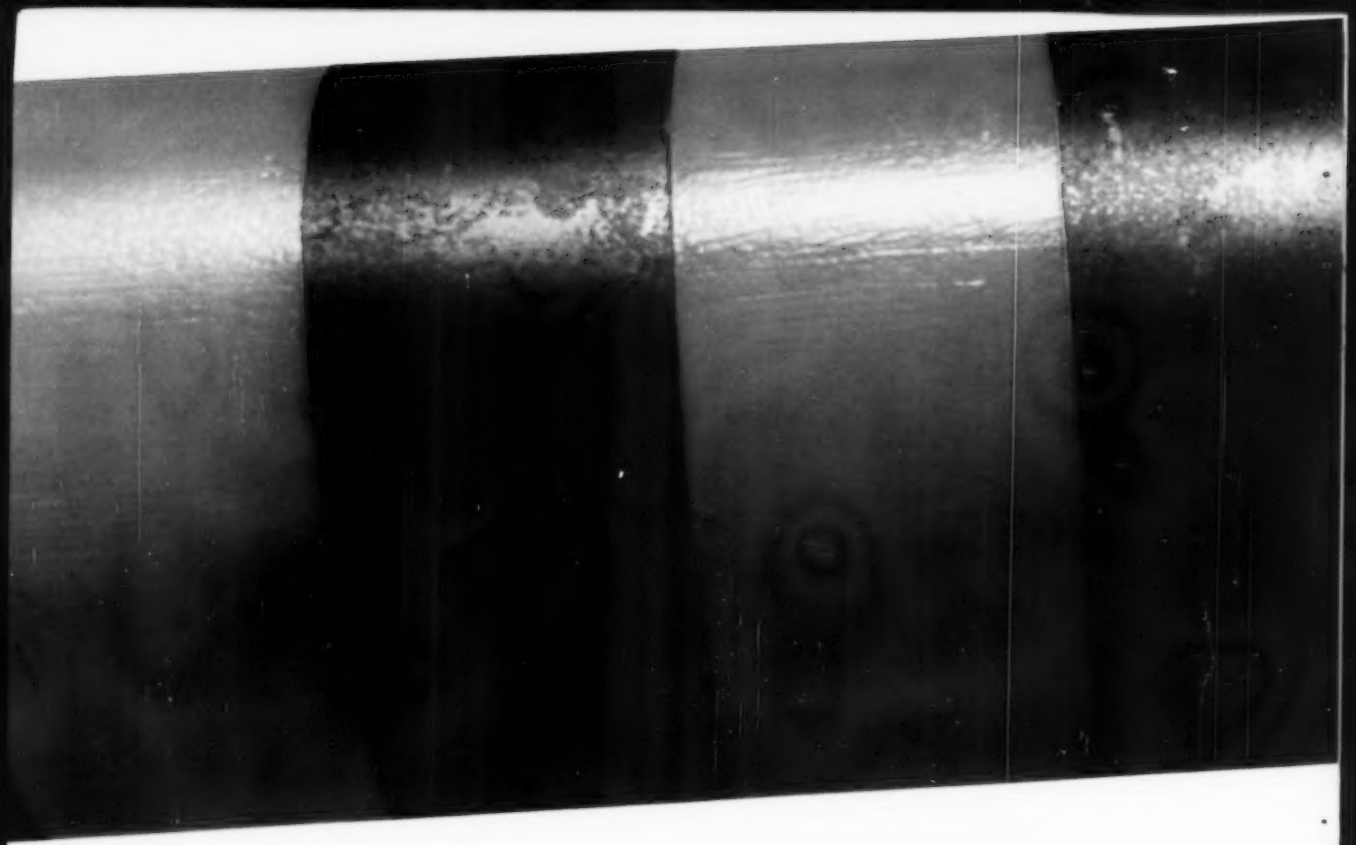
Sue: See you had a date with an oilman."

Lu: "Nope. Tore my dress on a nail."

Now Shell offers <u>two</u> packages to boost octane

Either process removes mercaptans almost completely at a cost of only a fraction of a cent per gallon. You save enough in TEL to pay this sweetening cost several times over. The same TEL dosage goes farther—gives you extra octanes cheaper than any other way. Both processes are now available for license. To find out which process is best for your operation, write Shell Development Company, 50 West 50th Street, New York 20, New York.

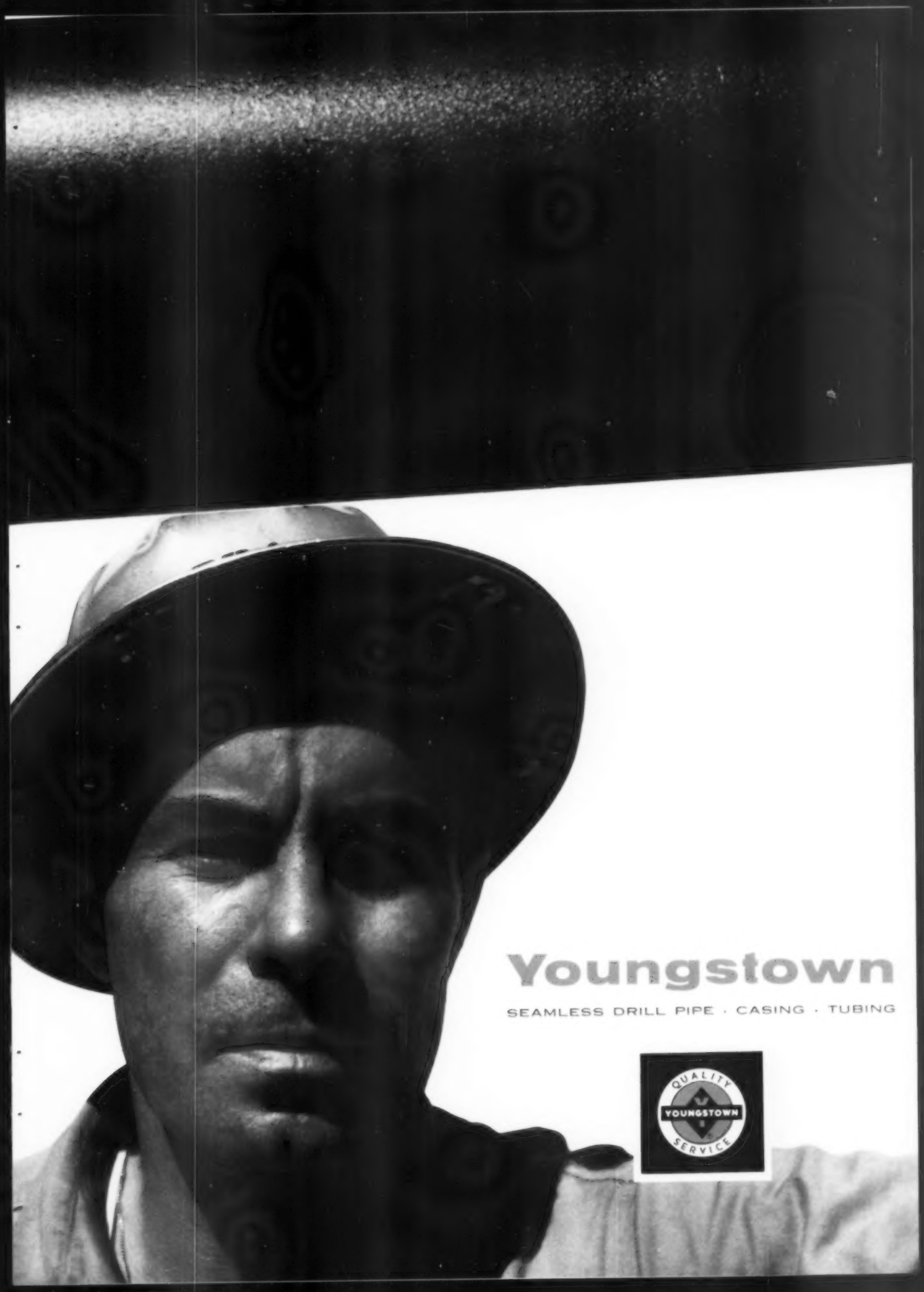
SHELL DEVELOPMENT COMPANY

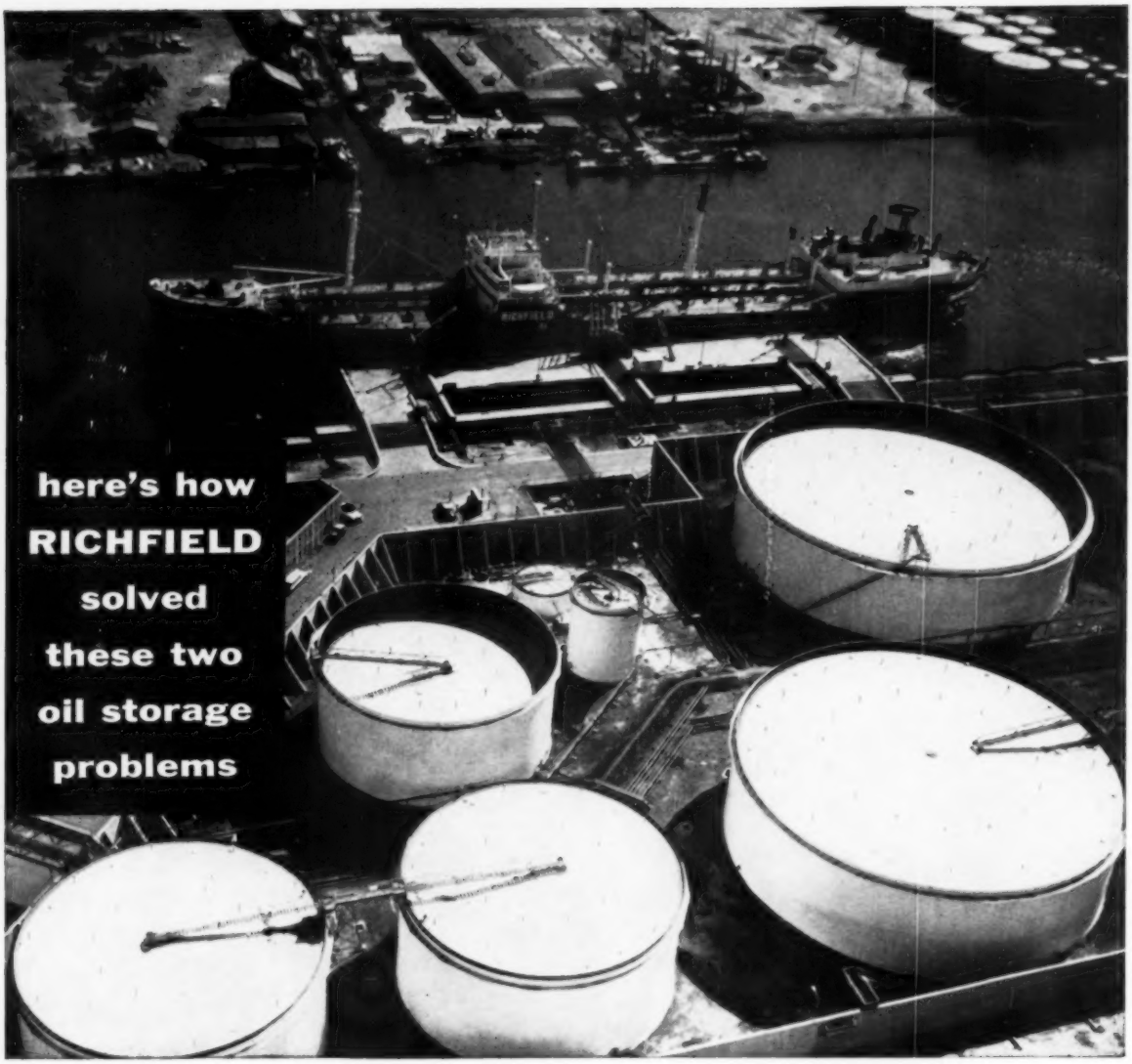


WHEREVER YOU FIND PIPE WITH ORANGE BANDS YOU'LL FIND A SMART PIPE BUYER

Youngstown's Oil Field Service Corps—nine qualified engineers—stand ready around-the-clock to consult on all your drilling problems. These professional men have offices in the oil fields and will gladly lend you their knowledge and long experience—either prior to drilling or during actual operations. They can tell you, too, about the pipe with the orange bands, the finest seamless pipe made anywhere. Call your nearest Youngstown District Office, today.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
Youngstown 1, Ohio


Youngstown
SEAMLESS DRILL PIPE · CASING · TUBING
QUALITY
YOUNGSTOWN
SERVICE



1. Fire Hazard 2. Vapor Loss

Here is an investment by Richfield Oil Company that pays off in safety and conservation. It is a seven-tank addition to Richfield's Marine Terminals that adds half a million barrels capacity. The tanks, built by General American, are equipped with Wiggins Floating Roofs with Wiggins Safety Seal that stops vapor loss and protects from rim fires.

Wiggins Double-Deck Floating Roofs with the Wiggins Safety Seal, reduce vapor space under the circumferential fabric to an absolute minimum. This practically eliminates losses due to thermal breathing and serves to prevent rim fires. The fabric is of a new, long-lived type and a special weather-hood protects it from the sun. The seal mechanism is always out of the liquid and the corrosive vapor space. Only the Wiggins Safety Seal gives you all these advantages.

PLATE & WELDING DIVISION
GENERAL AMERICAN
TRADE MARK

PLATE & WELDING DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South LaSalle Street, Chicago 90, Illinois
Offices in all principal cities

It pays to plan with General American

Meetings

Sept. 14-16—**INGAA**, annual membership meeting, Roosevelt Hotel, New Orleans, La.

Sept. 15-17—**Electrical Conference of the Petroleum Industry** sponsored by **AIEE**, Baker Hotel, Dallas, Tex.

Sept. 15-19—**13th Annual Instrument-Automation Conf. & Exhibit**, Philadelphia, Pa.

Sept. 18—**NGAA**, Rocky Mountain regional, Gladstone Hotel, Casper, Wyo.

Sept. 18-20—**Rocky Mountain Assn. of Geologists**, symposium of Pennsylvanian rocks, field trip to Paradox Basin, northwest and eastern Colorado.

Sept. 21-24—**ASME, Petroleum Mechanical Engineering Conf.**, Cosmopolitan Hotel, Denver, Colo.

Sept. 21-24—**American Institute of Chemical Engineers**, regional meeting, Hotel Utah, Salt Lake City, U.

Sept. 22-28—**ASTM**, Statler Hotel, Boston, Mass.

Sept. 24-25—**WPRA**, Rocky Mountain regional technical-industrial relations meet, Henning Hotel, Casper, Wyo.

Sept. 25-26—**Mid-Continent Oil & Gas Assn.**, Arkansas and Louisiana annual, Roosevelt Hotel, New Orleans, La.

Sept. 25-27—**Illinois State Geological Survey's biennial Petroleum Engineering Conf.**, University of Illinois, Urbana, Ill.

Oct. 1-2—**WPRA, 3rd Annual Stream Pollution and Waste Disposal Conf.**, Lassen Hotel, Wichita, Kans.

Oct. 1-3—**AAODC**, 18th annual, Adolphus and Baker hotels, Dallas, Tex.

Oct. 3—**AIChE**, South Texas Section, 13th annual technical meeting, Moody Center, Galveston, Tex.

Oct. 5-8—**Society of Petroleum Engineers of AIME**, fall meeting, Houston, Tex.

Oct. 6-7—**NACE**, southeast region meeting, Richmond, Va.

Oct. 6-8—**NACE**, northeast region meeting, Boston, Mass.

Oct. 7-8—**Texas Mid-Continent Oil & Gas Assn.**, 39th annual, Statler Hilton Hotel, Dallas, Tex.

Oct. 9-10—**ASME-AIME**, conference on fuels, Chamberlain Hotel, Old Point Comfort, Va.

Oct. 9-10—**California Natural Gasoline Association**, 33rd annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.

Oct. 10-11—**Assn. of the Desk and Derrick Clubs of North America**, Biltmore Hotel, Los Angeles, Calif.

NOMADS MEETING DATES AND SECRETARIES

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 903, 45 Rockefeller Plaza, New York 20, N.Y.

Houston Chapter, second Monday, Ye Old College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18171, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Michaels Restaurant, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 3771, Tulsa 9, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary, R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Tex.

World Petroleum Congress . . .

When the Fifth World Petroleum Congress gets underway in New York in 1959, it will be the first time the United States has been host to such a meeting. All previous Congresses, before and since World War II, have been in European capitals — London, Paris, the Hague, and Rome.

Because the oil industry of today and tomorrow relies to such a major extent on scientific research, these Congresses offer the only truly international forum for the discussion and evaluation of research information and other data gathered in laboratories and petroleum facilities throughout the world. Reports presented at the meetings stimulate fresh thinking and new approaches to many problems, and frequently lead to the undertaking of new projects by various specialized organizations.

Oct. 12-18—**OIL PROGRESS WEEK.**

Oct. 13-15—**AGA, 40th Annual Conf.**, Traymore Hotel, Atlantic City, N. J.

Oct. 13-15—**ASME-ASLE**, conference on lubrication, Statler Hotel, Los Angeles, Cal.

Oct. 13-16—**Society of Exploration Geophysicists**, annual meeting, Gunter Hotel, San Antonio, Tex.

Oct. 15-17—**NACE**, north central region meeting, Cincinnati, O.

Oct. 16-17—**AIME, Southern California Petroleum Section**, fall meeting, Biltmore Hotel, Los Angeles, Calif.

Oct. 16-19—**Permian Basin Oil Show**, Odessa, Tex.

Oct. 20-24—**NACE**, annual conf. & exhibition of South Central Region, Roosevelt Hotel, New Orleans, La.

Oct. 23—**AIChE**, 1958 All-Day Symposium, Statler Hotel, New York City, N. Y.

Oct. 23-24—**WPRA**, El Dorado regional technical-industrial relations meet, Rufus Garrett Hotel, El Dorado, Ark.

Oct. 23-25—**National Society of Professional Engineers**, fall meeting, St. Francis Hotel, San Francisco, Calif.

Oct. 27-28—**IPAA**, annual meeting, Statler Hilton Hotel, Dallas, Tex.

Oct. 31—**NGAA**, Southern regional meeting, Carlton Hotel, Tyler, Tex.

Nov. 6-7—**AAPG**, Pacific section, annual meeting, Los Angeles, Calif.

Nov. 10-13—**API** 38th annual meet, Conrad Hilton Hotel & Palmer House, Chicago, Ill.

Nov. 17-19—**NACE**, western region meeting, Los Angeles, Calif.

Nov. 19-21—**Society of Petroleum Engineers**, Local Sections, Venezuela.

Nov. 21—**NGAA**, Panhandle Plains regional, Herring Hotel, Amarillo, Texas.

Nov. 28-Dec. 4—**Electronic Computer Symposium and Exhibition**, Olympia, London, England.

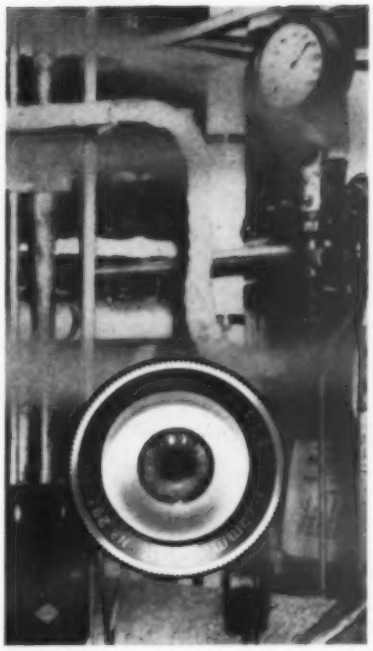
Nov. 30-Dec. 5—**ASME**, annual meet, Statler & Sheraton-McAlpin hotels, New York, N. Y.

Dec. 3-5—**API Oil Information Committee meeting**, Waldorf-Astoria Hotel, New York City.

Dec. 7-10—**American Institute of Chemical Engineers**, annual meeting, Netherland Plaza Hotel, Cincinnati, O.

1959

May 30-June 6—**Fifth World Petroleum Congress**, Coliseum, New York City.



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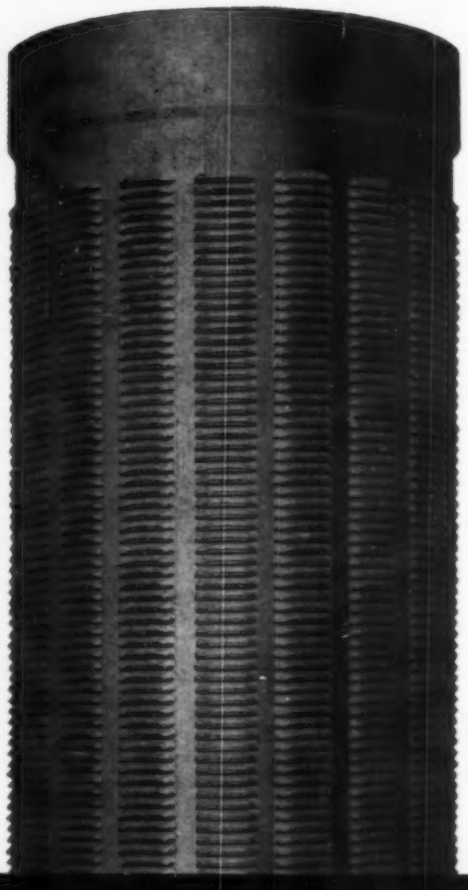

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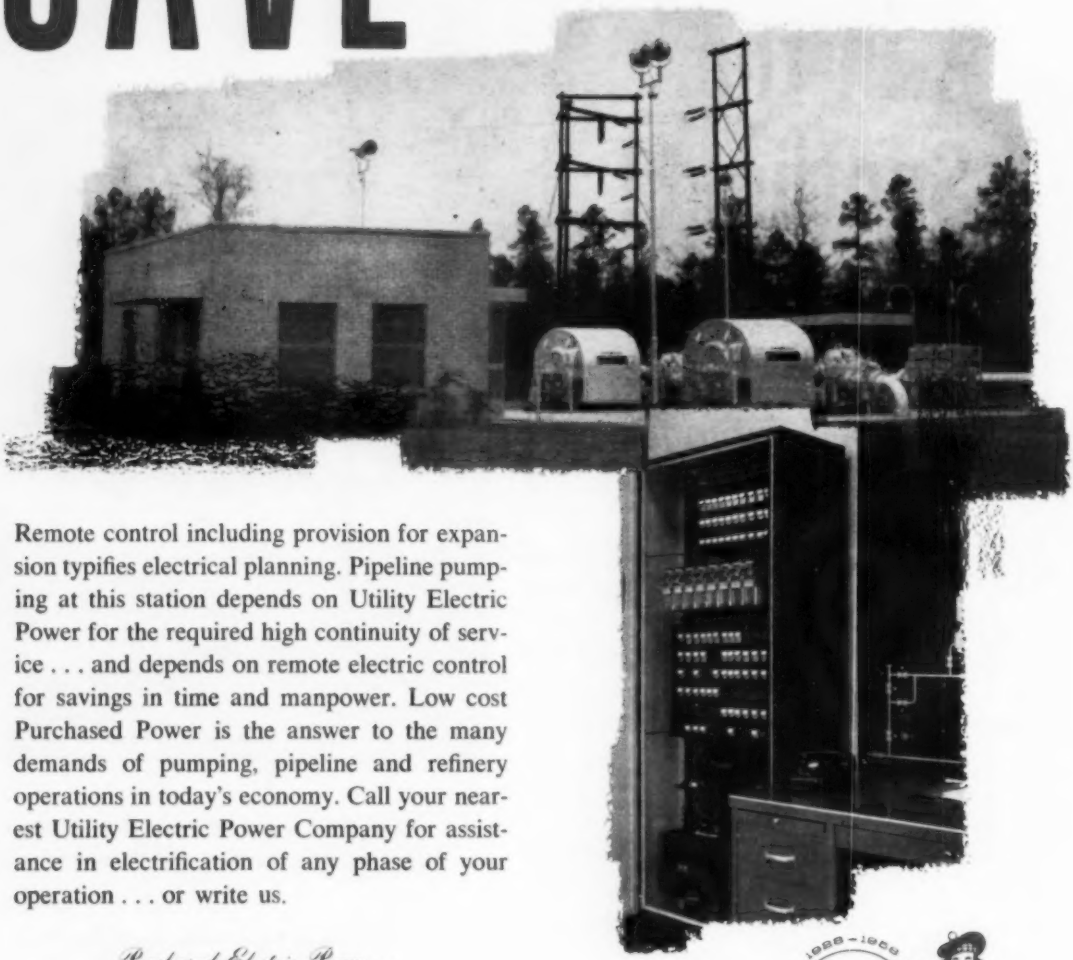

Remote control including provision for expansion typifies electrical planning. Pipeline pumping at this station depends on Utility Electric Power for the required high continuity of service . . . and depends on remote electric control for savings in time and manpower. Low cost Purchased Power is the answer to the many demands of pumping, pipeline and refinery operations in today's economy. Call your nearest Utility Electric Power Company for assistance in electrification of any phase of your operation . . . or write us.

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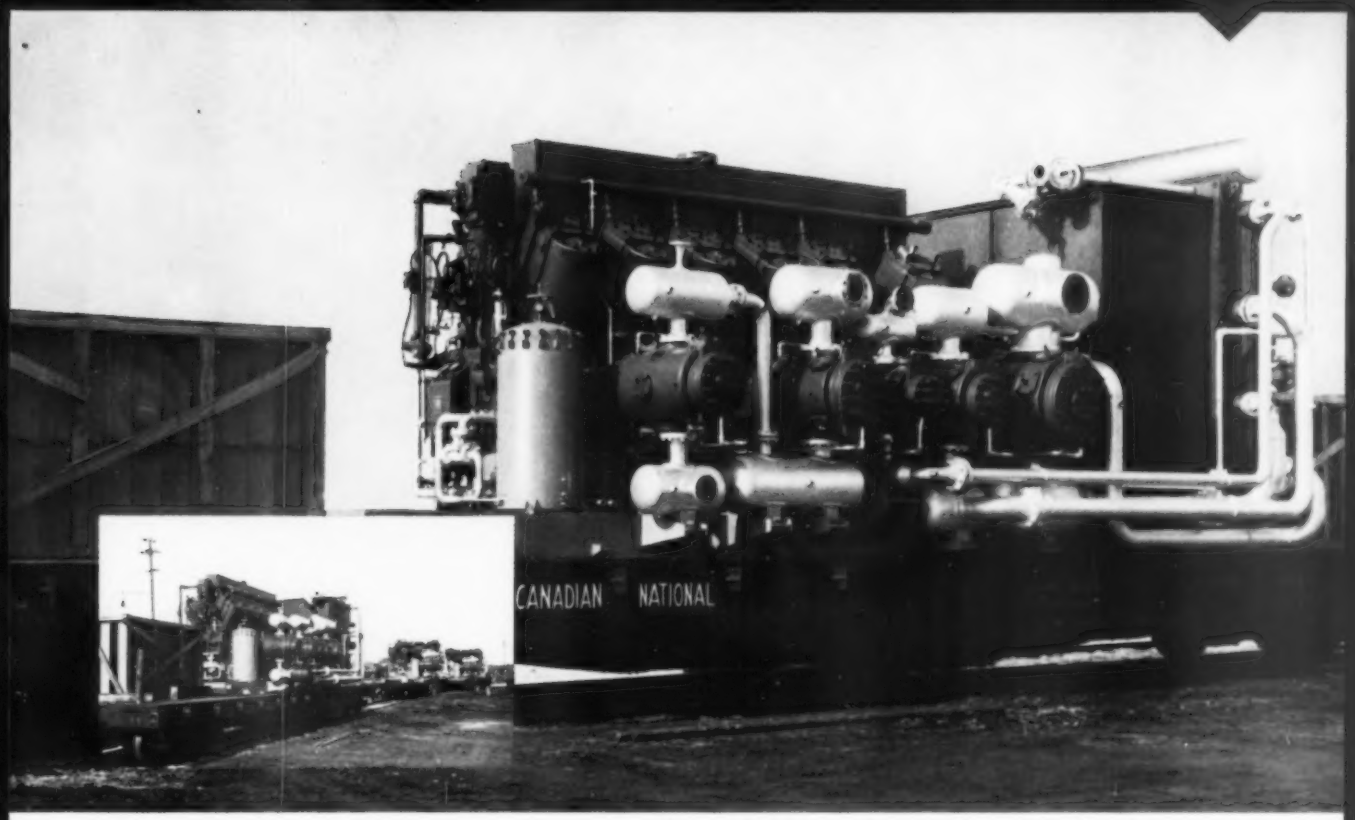

CANADIAN BUILT Beaird-Ingersoll-Rand, 660 h.p. 12SVG packaged compressor units have Young radiators with up-draft air discharge. Interstage gas, engine water and lubricating oil cooling sections are built into the radiator. Other sizes from 120 to 660 h.p.

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These three 660 h.p. Beaird-Ingersoll-Rand packaged compressor plants are among the first 18 Canadian-built units to be delivered by Beaird International, Inc., Calgary. This new Beaird subsidiary offers Canadian producers complete sales, service and available manufacturing facilities.

Designed for a major oil company, the units will serve a dual role in gas processing and boosting. Three stages will be used for gas boosting and two stages will handle propane for the chilling process. Another example of the flexibility possible in solving gas production problems, these compressors reflect Beaird's years of design and field experience.

With Canadian facilities, Beaird International offers a single source of responsibility from initial quotation to field service. Beaird offices in Caracas, Venezuela serve South American markets.

Wherever oil or gas is produced, there are skilled Beaird gas engineers to assist in finding an economical solution to your special operating requirements.

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LEAK-PROOF ONE-PIECE CONSTRUCTION from socket to tip of bourdon tube...accomplished by the exclusive Marsh "Conoweld" process.

STURDY "MARSHALLOY" CASE formed of boiler-plate thickness steel, copper clad inside and outside by "Marshalloy" process to give it all the durability and the corrosion resistance of solid copper with the dependable strength of steel.

SUPERLATIVE "MASTERGAUGE" MOVEMENT with exclusive "coined" sector gear, self lubricating, frictionless action and other refinements that add years to service life.

TYPES FOR EVERY SERVICE...wide range of bourdon tubes including stainless steels and monel. Full range of pressures, vacuum, compound gauges in endless sizes, case styles. Only Marsh has the "Safecase" for dangerous gauge applications.

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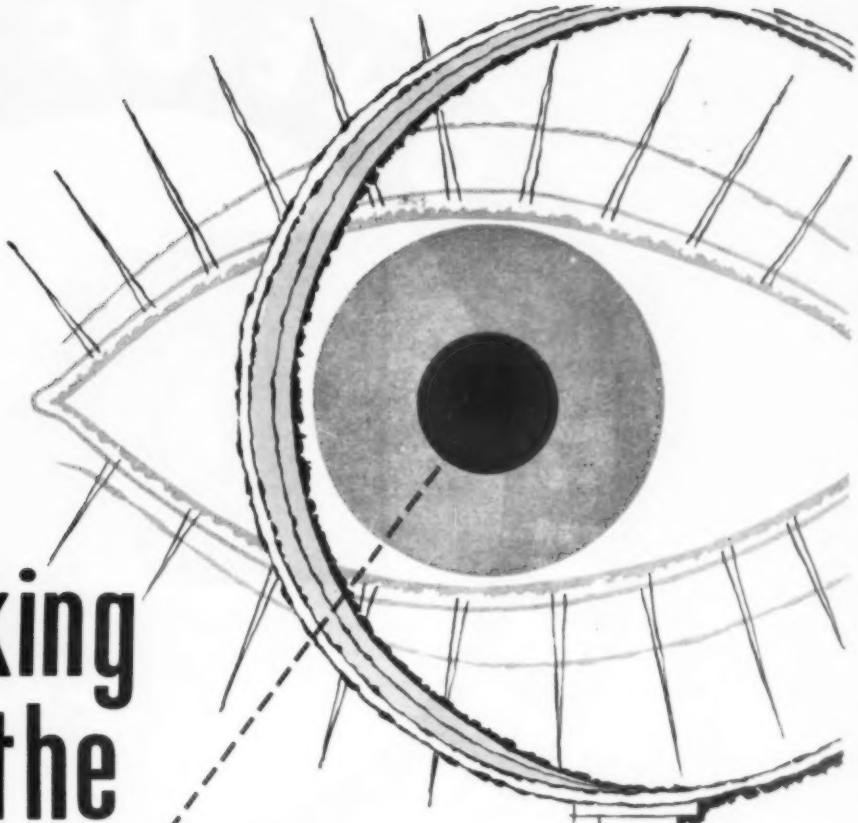

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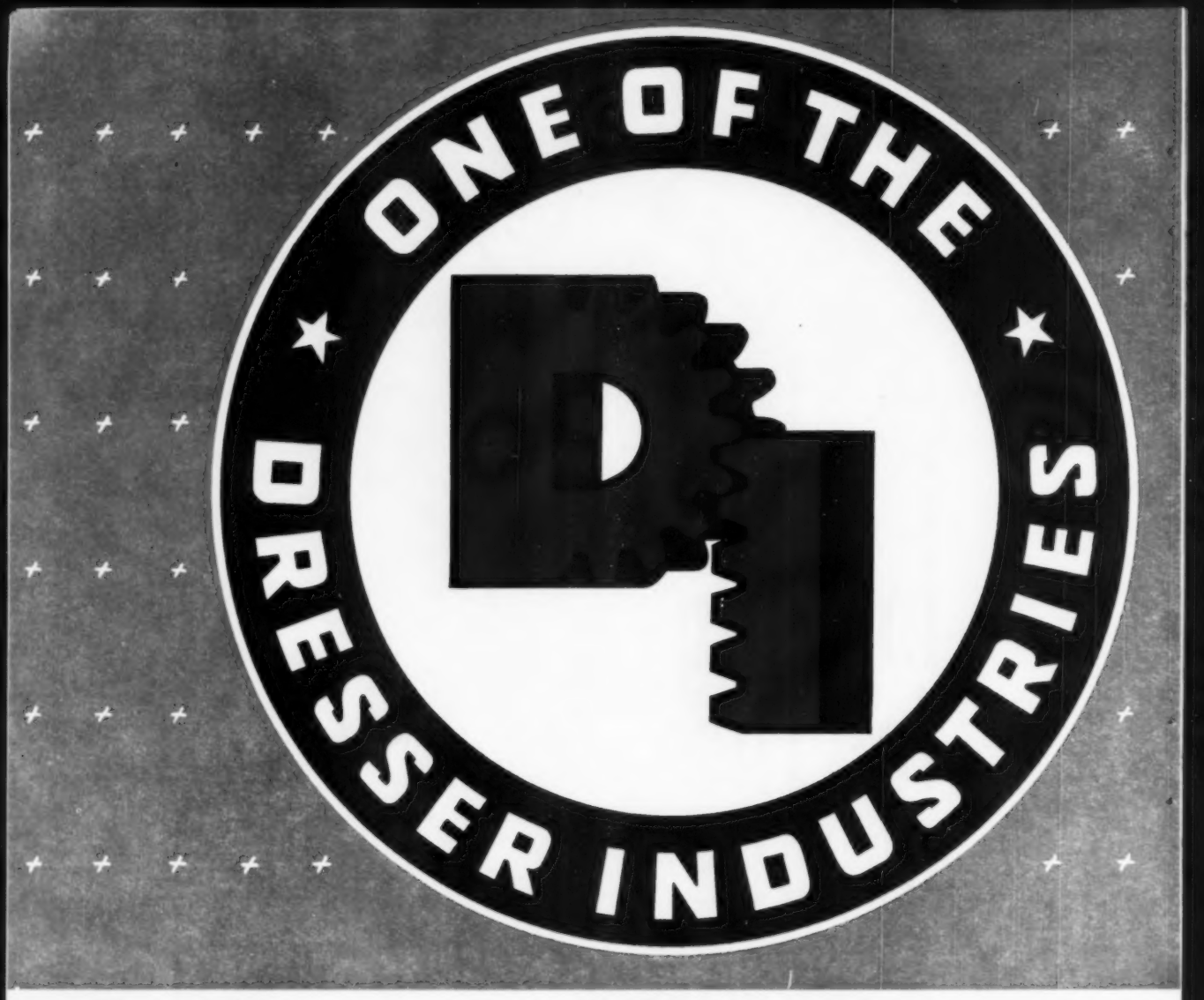

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MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar® and Magcogel® drilling muds and other specialized oil well drilling fluids and chemicals.

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• News • People — The Trade PARADE

ALL-ALUMINUM TEST ENGINE to check performance of all types of gasoline and oil additives in lightweight power plants has been installed by Du Pont's Petroleum Laboratory. New unit, a four-cylinder engine duplicating a companion test engine of conventional cast iron and steel, should provide comparative performance and combustion data for the oil and motor industry and should assist in the laboratory's development of new products to meet lightweight engine requirements.

TWO TOP OFFICERS who will guide the Petroleum Equipment Suppliers Association for the next year are steeped in oil industry experience. They are William T. Powell, PESA president, who is executive vice president of Continental-Emsco and Wallace D. Wilson, vice president, who is president of Wilson Supply. They were elected at the Association's Annual Meeting recently in Canada.

Powell is a native of Wales, Great Britain and a graduate of South Wales and Monmouthshire School of Mines (in 1923). He joined Emsco in Los Angeles in 1937 as chief engineer of the fabricating plate department and advanced until he was elected president of Emsco in 1952. On January 1, 1957, when Continental and Emsco merged, Powell became executive vice president in charge of manufacturing and engineering with headquarters in Dallas. He is also chairman and director of Emsco's British subsidiary, Emsco Engineering Company, Ltd.

W. T. Powell

W. D. Wilson

Wilson, PESA vice president, has been prominent in the oil well supply business for 46 years. He began his career as a bookkeeper with the Republic Supply Company in Houston in 1912 and advanced to secretary and treasurer of that company. In 1921 Wilson organized Wilson Supply Company. Since that time, under his guidance, the company has grown to be one of the largest independent oil and gas well supply firms. It has 21 branch houses covering all of the Gulf Coast of Texas and Louisiana, in addition to stores in West Texas and New Mexico. He is also president of Wilson Foundry and Machine Company and the Engineered Oil Tools, Inc. As a tribute to his contributions to the supply industry, Wilson, in 1953, at the International Oil Exposition in Tusla, was named "Grand Old Man of the Supply Industry."

NEW DISTRIBUTOR for Axelson subsurface pumps and sucker rods is Oil Field Sales & Service, S.A. of Axelson Manufacturing Company, Division of U. S. Industries. The complete Axelson inventory of parts and repair equipment has been purchased by Oil Field Sales & Service from Axelson's former distributor, Servicios Industriales, C.A.

LLOYD W. STANSBERRY has been appointed secretary-treasurer of W. C. Norris, Manufacturer, division of Dover Corporation, Tulsa, and assistant secretary and assistant treasurer of the parent company, announced W. L. Butler, Norris president. In this appointment he fills the vacancy left by the late Charles Huffman. Stansberry comes to Norris from a position as secretary-treasurer of McNamar Boiler & Tank Company, Tulsa.

L. W. Stansberry

Recently G. W. Davidson Jr., vice president sales, of the company, directed a closer study of product lines at the general meeting of sales personnel.

Representatives of Oklahoma, Louisiana and East Texas, Kansas, Rocky Mountain and Illinois Basin areas met here in the home office for concentrated attention on sales programming and product lines. Paul Hagaman, sales manager, and Jack Getty, division manager, were assisted in sales studies by the engineering staff under Al A. Hardy.

ARCCO

The World Over
wherever there is gas

ARCCO-ANUBIS
'Dry-Air GAS
GRAVITOMETERS

This new Arcco-Anubis Dry Air Gas Gravitometer determines and records specific gravity of gases automatically corrected to the humidity content of the air. The difference in weight between a column of GAS and equal column of DRY AIR is measured. This ratio represents the true specific gravity of the sample.

One bell of the instrument is filled with gas which is being measured, and the other bell is filled with dry air. Otherwise, except for the new instrument having one column for gas and one column for dry air, the unit is identical in operation to the standard gas gravitometer. When calibrated and properly installed, these instruments require little attention other than to wind the clock, ink the pen, and change the chart. Send for bulletin No. 101.

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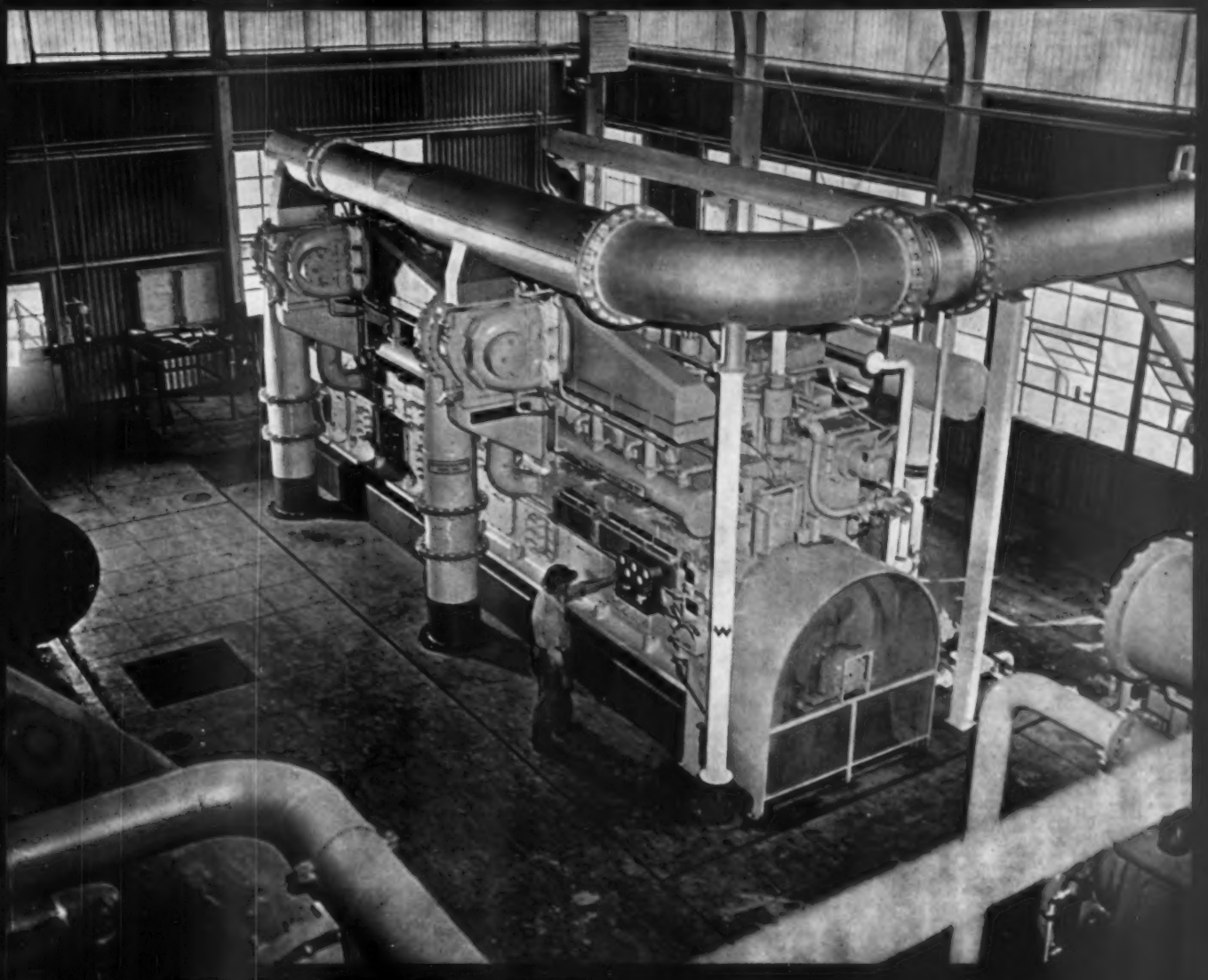
Send for Bulletin 101-R3



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THE ONLY 2-CYCLE ENGINE COMPRESSOR WITH SELF-SUSTAINED TURBOCHARGING!

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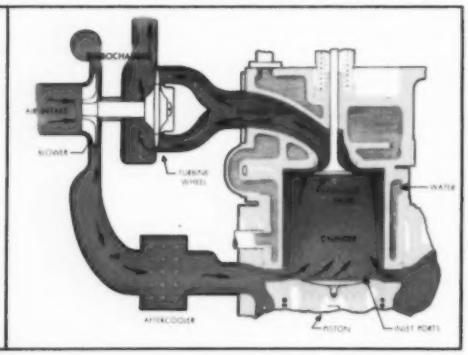
WORTHINGTON'S SUTC

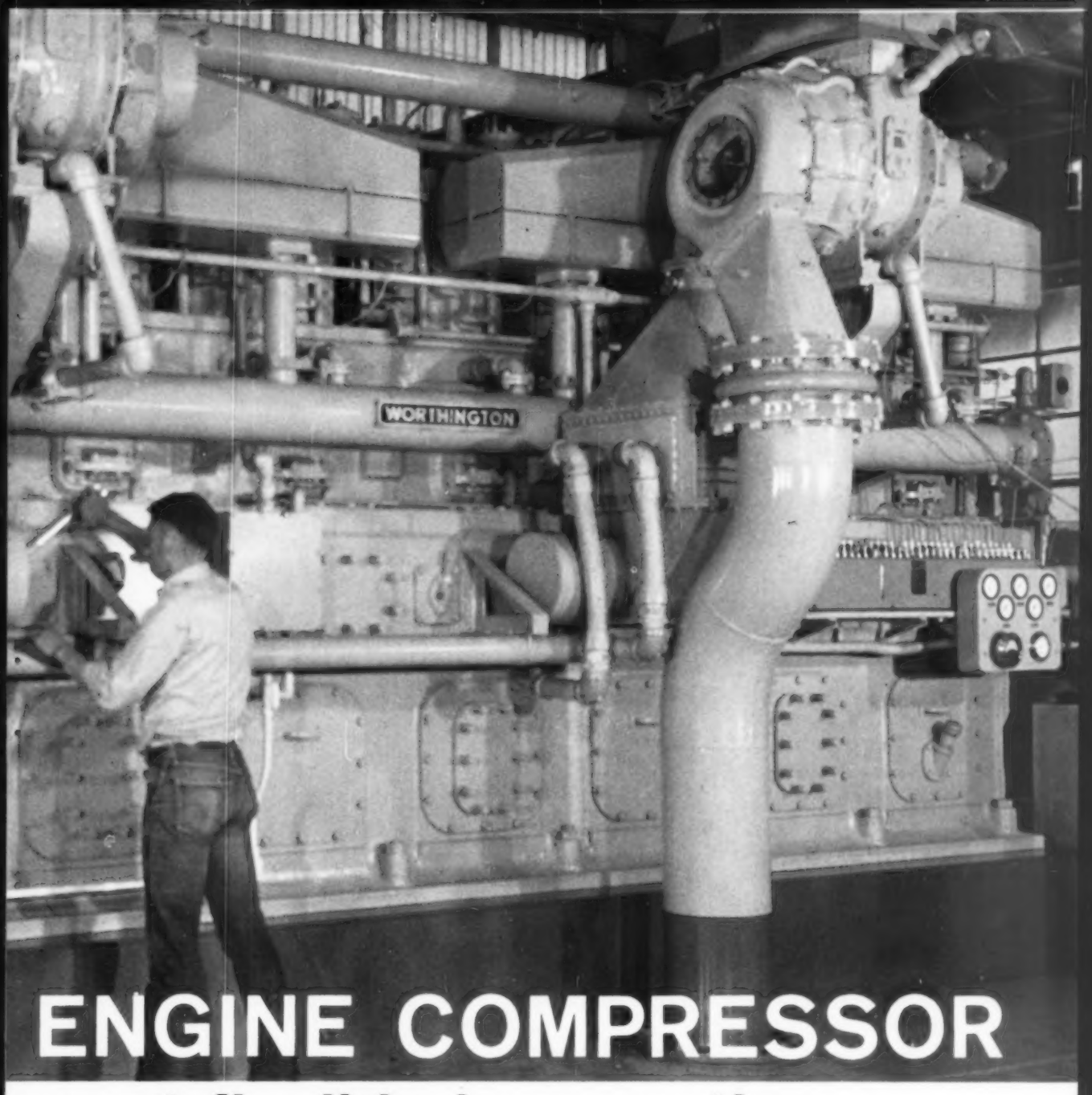
Easier starting, quicker loading,

TURBO-UNIFLO OPERATION

Straight through flow of air in the cylinder, the large inlet port areas (full 360 degrees), and the timed exhaust valves give maximum scavenging effectiveness with optimum back pressure.



Compact, reliable, efficient—the unique SUTC gas engine compressor with independent turbocharging has quickly become the outstanding engine compressor on the market. (Today, SUTC engines are in operation in chemical, petro-chemical plants and in pipeline service throughout the world!) Thanks to the self-sustained turbocharging feature the SUTC develops almost double the hp in the same space required by a non-turbocharged engine. Further, the field-proved Worthington TURBO-



ENGINE COMPRESSOR

most flexible in operation

UNIFLO system provides the most complete scavenging, resulting in a complete absence of residual gases in the combustion chamber.

Power — The SUTC integrates exhaust-powered turbocharging with field-proved Uniflo scavenging design for unequalled stability of performance over the complete range of speed and load requirements. The SUTC range: 1250 to 2500 hp. Supplied in 5, 6, 7, 8 and 10 cylinder in-line units.

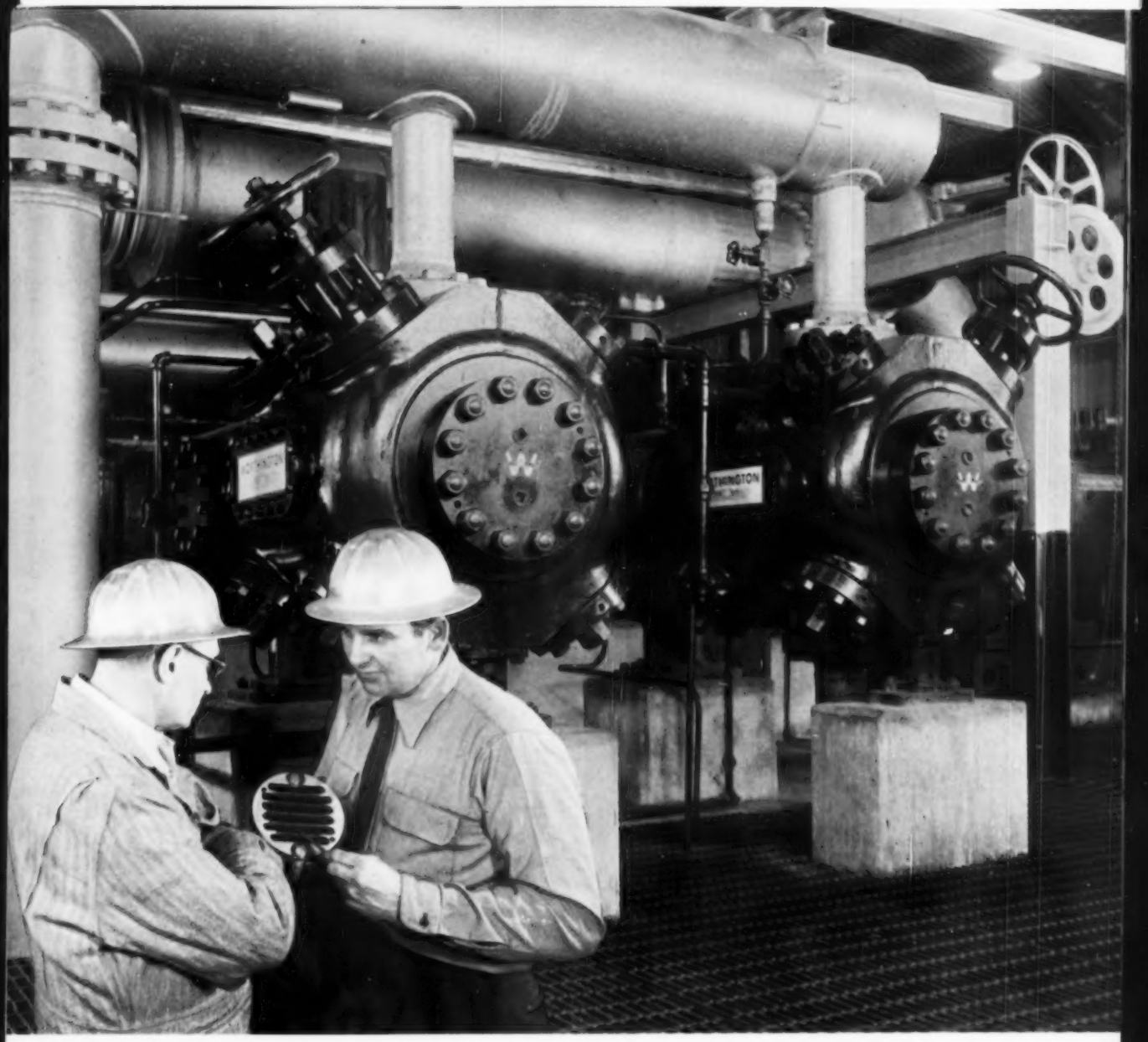
Economy—No engine compressor in this range is more economical. Low fuel consumption stems from the fact that sufficient exhaust gas energy is applied to give full turbocharged effect through *all* speeds and loads without added mechanical means for driving the supercharger.

Efficiency — Operating at relatively high compression ratio, the Turbo-Uniflo design affords much smoother combustion characteristics than other engines with lower compression ratios. This is due to the positively controlled timing arrangement, cylinder configuration and design of the exhaust manifolding.

For complete details on the SUTC turbocharged gas engine compressor, call your nearest Worthington District Office, or write: Worthington Corporation, Section 43-2, Harrison, New Jersey. In Canada: Worthington Canada Ltd., Brantford, Ont.

WORTHINGTON

Field-proved Worthington TURBO-



compressor-user survey shows

FEATHER VALVE PREFERRED 2 TO 1!

FEATHER VALVE

VALVE A

VALVE B

A recent survey of compressor users put the amazing Feather* Valve first by far in all four operating categories —simplicity of construction, efficiency, low maintenance cost and quiet operation. In addition, the Feather Valve was picked as the preferred compressor valve 2 to 1 over the nearest competing type of valve!

The lightest, fastest-acting valve available, the amazing Feather Valve provides very sharp action with virtually no slip or back-flow. It works with no impact . . . has no buffer plates or cushioning devices. Practically indestructible it assures long life with negligible maintenance costs. When buying your next compressor, look into Worthington's complete line of Feather Valve units. Worthington Corporation, Harrison, N. J.

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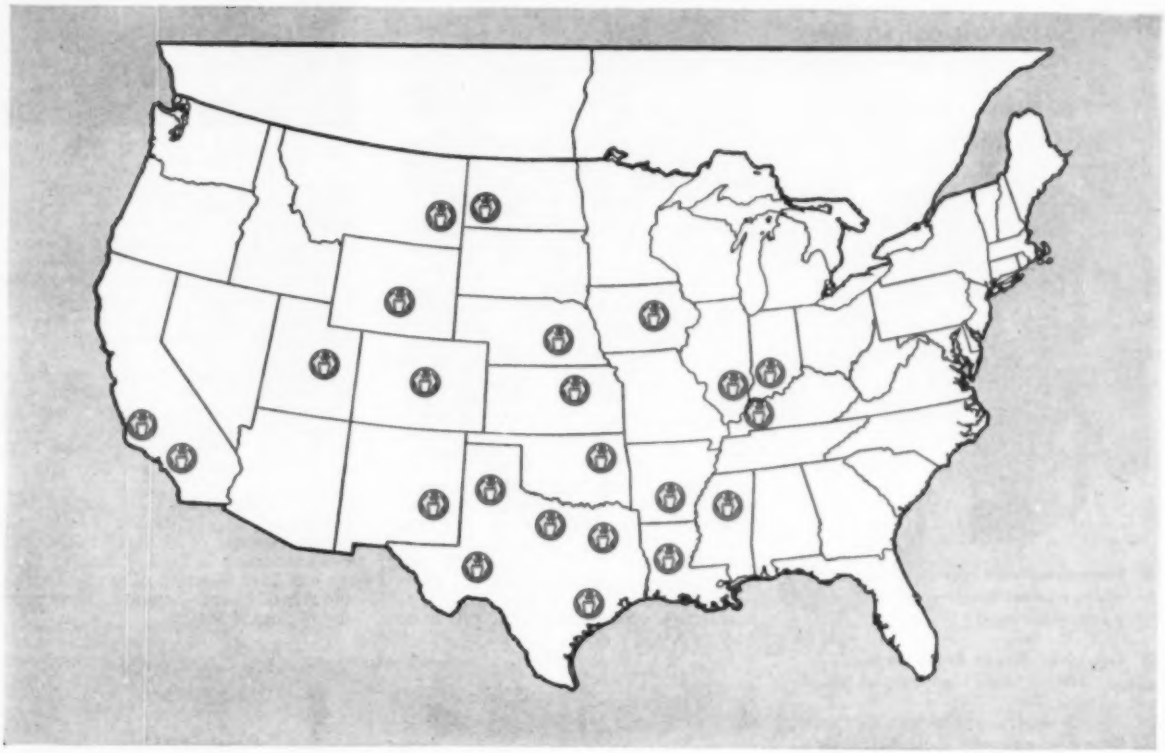
Financing from the* FIRST *in Dallas goes where you go!



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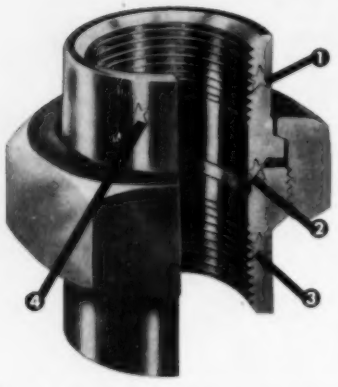
only
CATAWISSA
gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

. . . always specify
CATAWISSA

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA

Trade Parade

INCOMING ORDERS for its equipment took a decided upturn for June and should point the way for more successful third and fourth quarters of the year, G. V. Leece, president of Gardner-Denver Company, told the Security Analysts of San Francisco.

The most marked increase in sales came in construction equipment, Leece said, and oilfield equipment volume rose for the first time in several months. Gardner-Denver Company, with headquarters in Quincy, Illinois, manufactures compressors, pumps, rock drills and air tools.

NEW SIE OFFICE SYSTEM was installed by Rogers Geophysical at Roswell, New Mexico. The system from Southwestern Industrial Electronics — the MS-12/MS-17 GeoData System provides a fresh approach to the geophysical problems of the "Four Corners" area, and the lands extending through eastern New Mexico into West Texas.

By establishing the new center, Rogers now has an electronic data reduction service for geologists and geophysicists over a large and problematical area.

A COLORFUL, TWO-LEVEL industrial-educational exhibit center will be opened soon in the heart of Chicago by the Borg-Warner Corporation, R. C. Ingersoll, chairman announced. The display area is rated as probably the largest company-owned facility of its kind in the country from the standpoint of the number of products and divisions represented.

The center will be in the new Borg-Warner Building on the corner of Michigan Avenue and Adams Street directly across from the Chicago Art Institute.

A FOREIGN OPERATIONS department was formed by Graver Water Conditioning Company, New York, division of Union Tank Car Company. Jesse D. Crell has been appointed manager. The new unit will work in conjunction with the International Division of Graver.

Function of the department will be to expand the world-wide organization of representatives handling the complete line of liquid treatment equipment designed and manufactured by Graver. Graver offers equipment for industrial water and waste treatment and chemical processing.

A NEW SALES OFFICE in Fort Worth, for the states of Texas, Oklahoma, and New Mexico was announced by R. C. Sargent, division vice president of Pipe Linings of Wilmington, California. C. O. Davin, who has been with Pipe Linings since 1951 will be in charge.

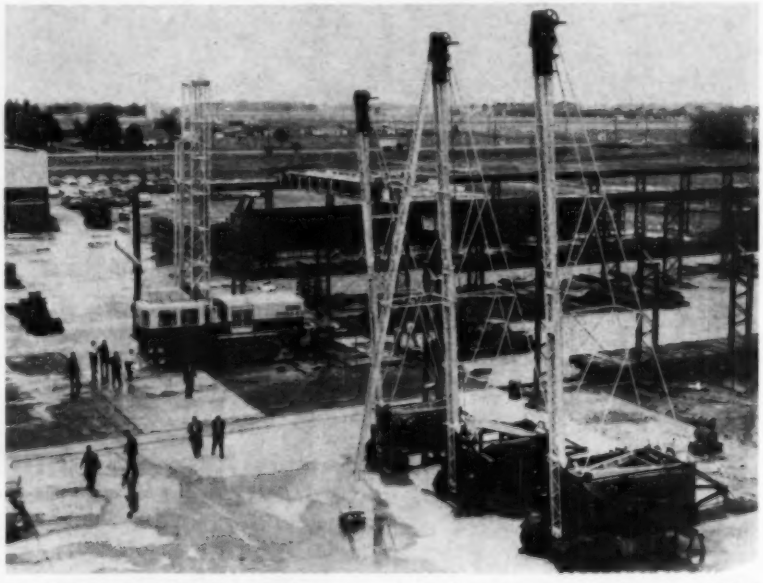
W. D. Thomson

C. O. Davin

Sargent also announced appointment of W. D. (Dave) Thomson to the Pipe Linings sales staff. He was previously with Amercoat and prior was assistant sales manager for Gladding McBean.

▸ **Allen B. Du Mont Laboratories.** Frank M. Girard has been appointed district sales manager of the mobile communications division. His territory covers South New Jersey, Delaware, and Eastern Pennsylvania.

▸ **Cooper-Bessemer Corporation.** Appointment of Guillermo Freytag as branch manager of its Mexico City office was announced. In his new capacity Freytag will have direction of the application and sale of Cooper-Bessemer compressors and engines in Mexico.



10,000 VISITED BUCYRUS-ERIE Company's new $12 million drill division plant at Richmond, Indiana, at an open house. The plant is headquarters for Bucyrus-Erie's entire drill division. Richmond will produce Bucyrus-Erie's complete line of water well, oil well, and blast hole drills for both domestic and foreign markets. Cut shows some of visitors at the new plant.

Henry Jameson is general manager of the drill division.

Trade Parade

ITS ENTRY INTO the field of industrial process control was announced by Genesys Corporation, a wholly owned subsidiary of Chance Vought Aircraft. Genesys will manufacture and develop commerical digital control computer systems as well as a supporting line of proprietary nucleus products for such systems.

J. P. Lekas

Product development will be headed by John P. Lekas, vice president, whose long and extensive career has marked many a milestone in the product and computer components field. Among his inventions are included a well-known airborne fire control systems tape recorder and numerous memory components of existing computer systems.

Systems engineering will be headed by Geoffrey Post, vice president. His systems and computer experience encompasses a wide scope of analog and digital

Geoffrey Post

J. F. Davis

computations and automatic control. Post has several important inventions in the computer input-output field and is the author of a large number of publications in control and computation.

Marketing activities will be under the direction of John F. Davis, vice president, whose years of engineering and sales activities include industrial instrumentation and computer marketing.

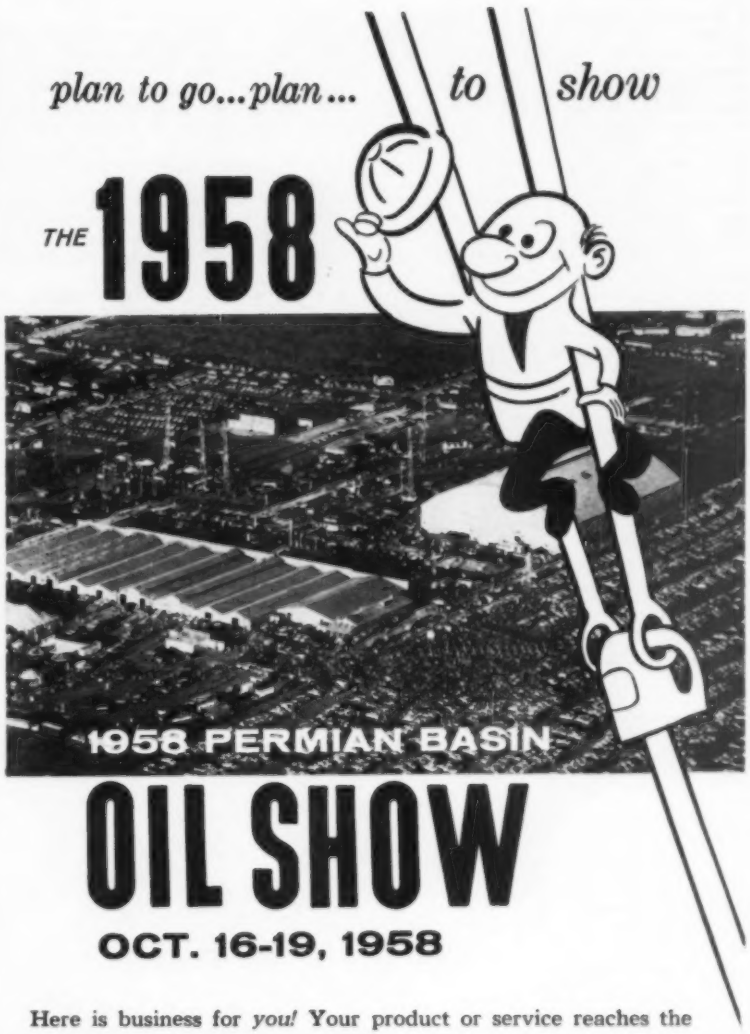
NEW FIELD PIPE TESTING division was set up by Brown Oil Tools at its Houston headquarters with E. L. Potts as superintendent. All testing equipment has been transferred to this new division. Potts and his staff are making a thorough study of present testing equipment and testing procedures to evaluate these in light of today's well completion techniques.

E. L. Potts

The new division superintendent has been associated with Brown since 1949. His engineering background has included experience with refining, construction, transmission and oil tool companies. From 1941 until the time he joined Brown, he was works manager at Halliburton's main plant in Duncan, Oklahoma.

▸ **Jones & Laughlin Supply.** H. D. Witt has been appointed store manager at El-Dorado, Kansas. He has been salesman there since 1952.

▸ **General Mills.** Thomas H. Boyd was appointed Philadelphia district sales manager for the Chemical Division. He will be headquartered at the new Philadelphia sales office at 1445 City Line Avenue, Overbrook Hills, Pennsylvania.



Here is business for *you!* Your product or service reaches the *heart* of the oil industry when you show at the Permian Basin Oil Show. It'll be the biggest in the industry this year, and you can't afford to miss it.

In '56, over 150,000 oil-people came to see the newest in oil equipment, techniques, and services... displayed by more than 500 exhibitors. This year there'll be *more* of everything.

Plan now to show. Be sure to go. Address your inquiry for information & contracts *right now,* while exhibit space is available.

the oilfield workers' show

permian basin OIL SHOW

316 W. 5th / ODESSA, TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Trade Parade

Ramo-Wooldridge Corporation. Dr. Ralph P. Johnson, formerly vice president, research and development, was named group vice president in charge of the General Electronics Group of Divisions. He will be responsible for directing all research, engineering, manufacturing, and administrative activities of the company except those of Space Technology Laboratories and The Thompson-Ramo-Wooldridge Products Company, both of which will report separately to the president.

Dr. Burton F. Miller, formerly vice president and director of the communications division, becomes vice president and director of advanced systems planning, and will participate with Drs. Wooldridge and Ramo in planning and arranging for the future entry by The Ramo-Wooldridge Corporation and its affiliates into major new product areas.

Milton E. Mohr, formerly vice president and director of the control systems division, has been named vice president, engineering, and will be responsible for the control systems division, communications division and the Electronic Instrumentation Company. The latter, a division of The Ramo-Wooldridge Corporation, is in Denver, Colo.

Irwin A. Binder, vice president, manufacturing, will have direct responsibility both in Denver and Los Angeles for the activities of the Manufacturing Division.

Universal Oil Products Company. D. B. Carson has been named manager of the engineering department, R. E. Sutherland, vice president of engineering announced. Carson's post is newly created in an expansion of the engineering department to meet needs of UOP's increasing business in petroleum refining and petrochemical process design. He will have general supervision of all activities of the department, including project engineering, process engineering and engineering services.

L. O. Stine was appointed manager of pilot plants, where new processes are developed and established processes are adapted to commercial operation.

Karl T. Hartwig, placed in charge of the project section, which includes construction services and coordination of design and construction activities. He formerly was a project coordinator.

J. H. Vavra, made head of engineering services section, responsible for drafting, estimating and mechanical design. He formerly was chief estimator.

Adalph H. Widowit, formerly advertising manager of Skil Corporation, Chicago, joined the public relations staff at Des Plaines, Illinois.

Schlumberger Well Surveying Corporation. Dr. Clark D. Goodman, a noted nuclear physicist, was elected vice president and director of research at the laboratories in Ridgefield, Connecticut. Dr. Goodman will serve under A. Blanchard, Vice President - Technique.

The physicist's most recent association was with the Atomic Energy Commission as Assistant Director of Technical Operations, Division of Reactor Development. He recently resigned that position as well as resigning from the Massachusetts Institute of Technology, where he had been a member of the faculty and active in the field of nuclear physics for nearly 20 years before he joined AEC in 1955.

Beckman. James D. Mixon was named field service engineer at the process instruments division office, Chicago. Mixon has been with Beckman Instruments since January, 1957, having served as lead man for final instrument inspection, Scientific Instruments Division.

A. O. Smith Corporation. A number of sales organizational changes affecting meter, service station pump divisions have been announced. J. W. Harris has been promoted from area manager at Houston, Texas, to sales manager, engineered products, on a national basis.

W. T. Schultze has been promoted to area sales manager, Northeast Territory, with headquarters in New York.

W. D. Burns has been appointed area sales manager, Plains Territory, with headquarters in Tulsa, Oklahoma.

Philco Corporation. John B. Hunt has been named assistant general manager of the government and industrial division. He will be responsible for the financial aspects of the Division and its Western Development Laboratories at Palo Alto, California, and the Philco subsidiary Sierra Electronic Corporation at Menlo Park.

As a senior consultant for the management consulting firm of McKinsey & Company, Hunt gained considerable experience in management controls, organization, finance and basic business policies.

Worthington Corporation. George Steven, formerly assistant general manager at the Buffalo division, has been named general manager of the compressor and engine division. He replaces Vice President Austin C. Ross who has retired after serving the corporation for 26 years.

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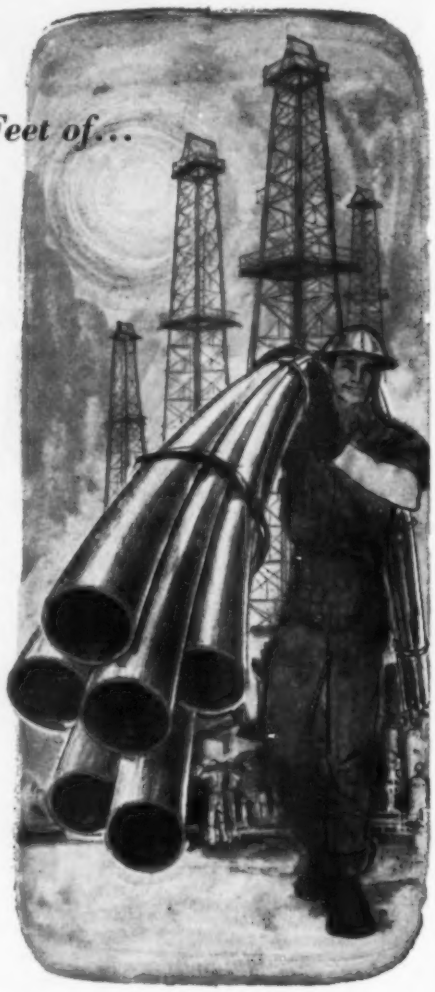
KRALOY

HIGH-IMPACT

PVC PIPE

in oil-country use today



This proves that there is no substitute for Kraloy experience.

KRALOY is the most experienced manufacturer of PVC plastic pipe for the petroleum industry. The first polyvinyl chloride lead line installed in this country—at Great Bend, Kansas—was Kraloy Pipe. Kraloy High-Impact PVC today is preferred by production men for maintenance-free service in lead lines and disposal systems. Kraloy customers use Kraloy High-Impact PVC pipe for lead lines, gas lines, and salt water lines because Kraloy normally eliminates (1) sulphur corrosion due to sour crude, (2) paraffin buildup, (3) corrosion and scale, (4) trouble from soil electrolysis.

YOU Benefit From KRALOY'S Quality Control

To insure quality control, random samples of Kraloy Plastic Pipe are tested daily in Kraloy's own laboratory for burst pressure, impact resistance, and tensile strength under standard ASTM specifications.

Kraloy Pipe is Sold Only Through Qualified Supply Stores

Warehouse stocks and sales representatives:

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John Piersol, 13913 Hillcrest Rd.
DALLAS 30, TEXAS

The Mack Company, 2005 Hackney St.
HOUSTON 23, TEXAS

J. W. Massey, Jr., P. O. Box 2224
MIDLAND, TEXAS

Ross Howell, 209 E. Scott St.
WICHITA FALLS, TEXAS

The Becker Sales Company, P. O. Box 2262
TULSA, OKLAHOMA

The Becker Sales Company, 3013 S. High St.
OKLAHOMA CITY, OKLAHOMA

Robinson Oil Field Specialists, 616 Main St.
GREAT BEND, KANSAS

For Detailed Information Write Dept. PE98

KRALOY *plastic pipe co., inc.*

4720 East Washington Boulevard, Los Angeles, Calif.

Subsidiary of the Seamless Rubber Co., a Rexall Drug Co. Subsidiary

BP-169

Trade Parade

United States Rubber. Dr. Thomas L. Wilson has been appointed manager of the Research Center in Wayne, New Jersey. He replaces Dr. Arthur E. Brooks, who was recently appointed an assistant director of the research and development department. In his new assignment Dr. Wilson will manage the company's multi-million dollar Research Center opened last year in Wayne.

Otis Engineering Corporation. Johnny Wall is new manager of the division office in Odessa. He was formerly stationed in Odessa as a sales engineer. He succeeds Jack Russell, who was promoted to assistant manager of field sales in the Dallas home offices.

United States Steel. Jackie Ray Hunnicutt, field representative of Oil Well Supply Division, was transferred from Denver City, Texas, to Kermit, Texas.

Ivan A. Jones was made Oil Well Supply field representative at Wewoka, Oklahoma.

Frank C. Nuhfer is the new area engineer at Columbus for Oil Well Supply.

The appointments of a store manager and a field representative for the Oil Well Supply Division at Morgan City, Louisiana, were announced by M. F. Jones, Gulf Coast Area manager of the division. New store manager, James H. Rudd Jr., goes to Morgan City from Houma, Louisiana, where he has been field representative since 1956. Joe Charles Bradley, new Morgan City field representative, was employed by the division in 1957 at Harvey, Louisiana.

General Electric. A. A. Watson has been named manager-marketing and assemblies and components sales. Watson has been associated with General Electric since 1936, when he joined the Trumbull Electric Manufacturing Company, then a G-E affiliate, as a sales engineer.

R. C. Wilson has been named manager-manufacturing and plant operations. In his new assignment Wilson will have responsibility for the manufacturing function and the five plants of the distribution assemblies department. He will make his headquarters in Plainville, Connecticut.

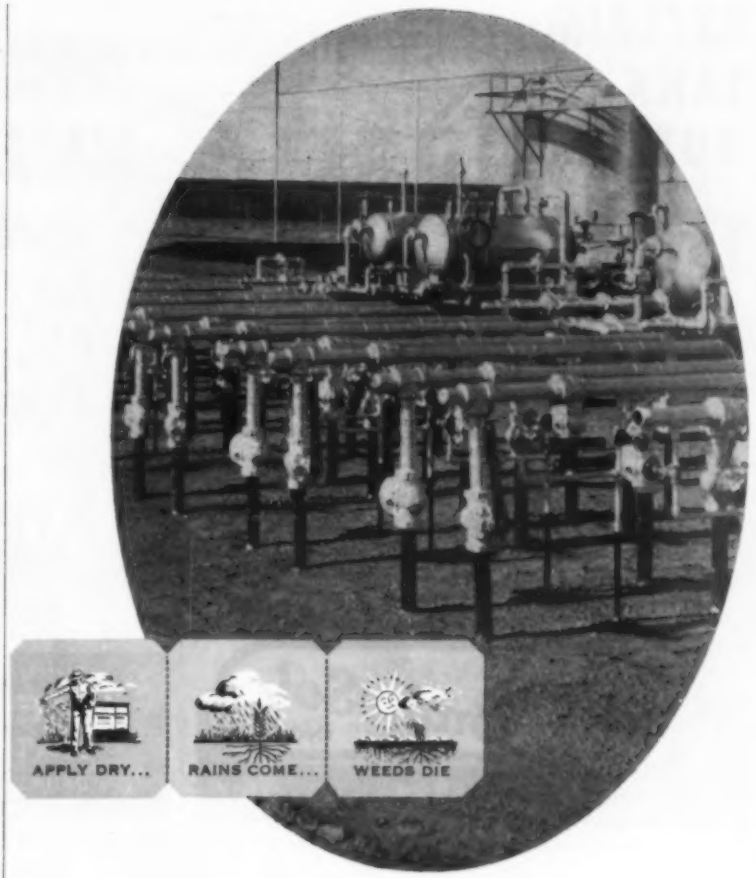
H. R. Oldfield Jr., former general manager of the computer department, has been appointed general manager of a new company component, the name of which has not yet been disclosed. He is succeeded by C. C. Lasher, formerly manager of marketing of the computer department. Both appointments are effective immediately.

The computer department is the youngest one in the company. It was established in 1956 with headquarters in Phoenix, Arizona, to develop and manufacture electronic computers and components.

Houston Oil Field Material Company. George E. Matter has been named executive vice-president and general manager of Homco International, C.A. He began with Homco as a directional drilling engineer in Corpus Christi, Texas in 1941. In his new position, Matter will direct all entities of Homco International, C.A. with offices and warehouse facilities in Los Morochas, Venezuela.

Milwhite Mud Sales Company. Gilbert Pollard, a member of the sales department for the past five years, was appointed sales manager.

Robert A. Jung, who has been associated with the drilling mud industry since 1942, and has acted in the capacity of engineering co-ordinator for the company, was appointed manager of engineering.



Here's how you can solve your toughest weed problems...

Get acquainted with new Concentrated BORASCU weed killer! This effective and economical way to keep ground free of weeds and grasses is one of the easiest. There's nothing to mix...no water to haul ...just clean dry borate granules for broadcasting by hand or for application from any mechanical spreader. Concentrated BORASCU is lastingly effective... for as long as 24 months in many cases! So, to lower your costs for "grassing" and, at the same time, to achieve a superior job, start using Concentrated BORASCU weed killer... the kind that's NONPOISONOUS, NONFLAMMABLE, and NONCORROSIVE to ferrous metals.

Send for new Service Bulletin 10W

UNITED STATES BORAX & CHEMICAL CORPORATION

Pacific Coast Borax Company Division

630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA

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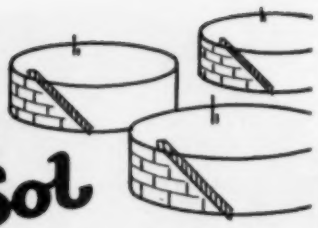
E-41

RECLAIM TANK BOTTOMS with BrakeSol



the most effective chemical for treating

PARAFFIN

The money you make on reclaimed tank bottoms by using BRAKESOL will be substantially more than the cost of treating . . . including chemical and labor. Safe for use in production, pipeline and refinery equipment . . . Contains no chlorides, sulphides or other halides. BRAKESOL Treating Engineers have the experience and know-how to do a successful job. Contact them now!

Treating Engineers Available at These Locations

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OR CALL YOUR SUPPLY STORE

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Edmonton, Alberta 66-6950
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DALLAS, TEXAS

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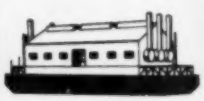

AND THANKS TO OUR EXPERIENCE AND FACILITIES, WE DO IT BETTER

Among men who know marine vessels best, it's a recognized fact that Levingston builds better tugs and barges. There are several important reasons why: First, Levingston has personnel with many years of experience. Second, Levingston has a completely integrated yard with the most extensive production facilities. Third, every job at Levingston receives a higher degree of expert attention.

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SHIPBUILDING COMPANY • ORANGE, TEXAS

For complete details, send for free brochure

Here's the newest development in wire rope—

USS FIBRESEAL

It's TIGER BRAND of course!

This new wire rope was developed to meet the need for longer life in sand lines, swabbing lines, coring lines and cable tool drilling lines. It has a plastic impregnated fiber core which combines the good deterioration resisting properties of a plastic core with the excellent strand supporting characteristics of a fiber core.

The plastic protects the fiber and prevents absorption of acids and other hole fluids. Consequently, the rope retains its structural balance even when used in drilling or swabbing acidized or sour wells.

One of these new Fibreseal ropes was used in cleaning out 23 wells. Twelve of the wells were acidized and very corrosive. After four months of service, the rope was checked for deterioration. The core was found to be in good condition, having resisted all well fluids without trouble. The user was extremely well pleased with the extra service life he obtained, and the behavior of the line has been very satisfactory.

Send the coupon for the complete story on USS Tiger Brand Fibreseal Wire Rope.

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Series 2800—The oil man's Level Controller for Lease Automation

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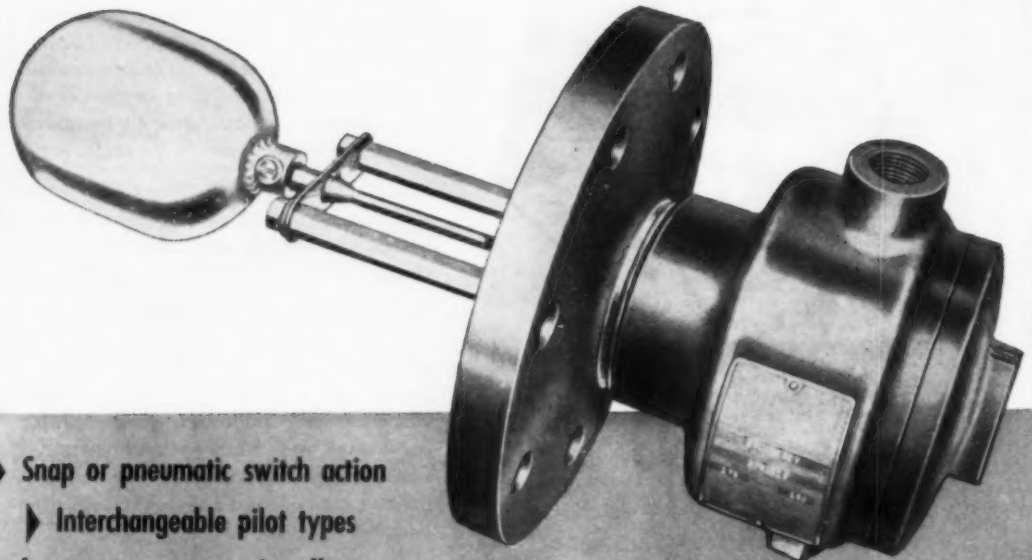
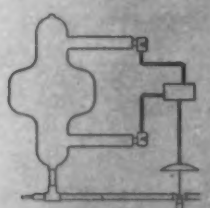
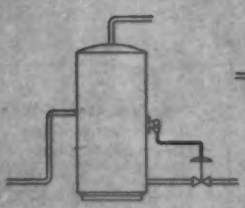


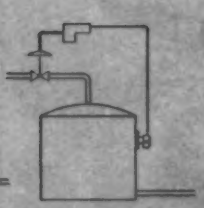
- Snap or pneumatic switch action
- Interchangeable pilot types
- Low cost . . . easy to install



Type 2806-252V controlling level of volumetric measurement vessels for accurate control of liquid volume.



Separator or line scrubber control



High level shut-in control in tank farms

252V HOUSING ASSEMBLY

Sizes—4" iron or steel, flanged, with ratings up to 900# ASA. Available with coupling type, welding type or screwed bar housing. Float size 3½" x 6" stainless steel. Pressures up to 1000 psi. Solid plastic available for pressures over 1000 psi. Flexure tube—K Monel.

PILOT ASSEMBLIES

Type 2800—Explosion-proof electric switch assembly—snapping range—½"—1" with 1.0 specific gravity liquid. Electrical rating—20 amp., 125, 250, 440 volt AC. Color coded wiring.

Type 2806—Pneumatic relay with snapping range of ½" to 1½", with 20 psi air supply.

Type 2807—Pneumatic relay for throttling service. Available with horizontal or vertical floats for wide range of proportional band requirements.

The float actuated 2800 series is a low cost, snap acting liquid level control available with either electric (explosion-proof) or pneumatic switch action. Pilot is interchangeable on float housing assembly. Features the stab-in type of tank mounting for easier installation.
Write for Bulletin F2800 for complete information.

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SINCE 1880

HIGH PRESSURE—

HOT TAPS MADE EASY

. . . AND *Safe*

MUELLER® Curb Valve Tees and DH-2 Drilling Machines make hot taps in high pressure transmission lines a cinch. Lateral connections are made quickly under completely controlled conditions. And a means of shut-off is provided right at the transmission line.

Just 5 simple steps!

1. Weld tee to transmission line.
2. Complete branch line.
3. Drill through tee into transmission line with DH-2 Machine as shown at left.
4. Insert valve stem into tee with completion machine.
5. Cap tee and open valve to complete installation.

Specifications . . . . . ▸

MUELLER NO-BLO PRODUCTS

MUELLER CO. Since 1857 SERVING the Water and Gas Industries QUALITY

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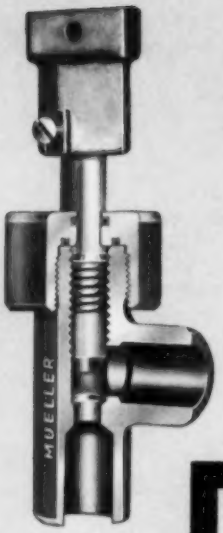
Factories at: Decatur, Chattanooga, Los Angeles, In Canada: Mueller, Limited, Sarnia, Ontario

MUELLER® CURB VALVE TEES GIVE POSITIVE SHUT-OFFS

up to 1200 p.s.i.



Metal-to-metal seat contact in both closed and opened positions gives tight shut-offs and prevents leakage. "O" ring stem and cap seals give a double seal against leakage. If desired, tee may be operated from ground level through a curb box.

H-17800 CURB VALVE TEE

Welding or threaded inlet
— sizes ¾" through 2"
Welding, threaded, extended, Dresser or insulating outlet
— sizes ¾" through 2-½"

extended inlet type
— for use with reinforcing saddle

H-17801 CURB VALVE TEE

Welding inlet
— size 2"
Cone-shaped 1" welding outlet
— for 1", 1¼", 1½" and 2" pipe

RECONDITION VALVES UNDER PRESSURE

Mueller Curb Valve Tees may be kept in perfect operating condition for years. If the valve becomes worn, the following maintenance can be done with the valve on the line and under full line pressure.

- Valve stem may be removed and body seat refaced
- Stem seat may be refaced or a new stem inserted
- Both "O" ring seals may be replaced

power-operated drilling machine speeds cutting time!

DH-2 DRILLING MACHINE

Drills ¼" through 2⅛"
14" boring bar travel
Automatic or manual tool feed
Power or hand-operated
Air motor or gasoline engine power units
Working pressures to 1200 p.s.i. at 100° F.
Working temperatures to 500° F. at 1000 p.s.i.

H-17145 COMPLETION MACHINE

Companion machine to DH-2
Inserts and extracts valve stems
Refaces valve body seats
Hand-operated, balanced-pressure design
Working pressures to 1200 p.s.i. at 100° F.
Working temperatures to 500° F. at 1000 p.s.i.

Write for complete information on these and other NO-BLO® fittings, machines and equipment

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FOR small diameter tanks in MARKETING, BULK STORAGE, PRODUCING and REFINING OPERATIONS.

Suitable for storing gasolines, crude oils, and hydrocarbon chemicals.

The HAMONDFLOTE COVER is constructed of rigid polyisocynate foam—a plastic material with exceptionally low density and high load carrying capacity.

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Trade Parade

Continental-Emsco Company. William Storms was appointed merchandise manager in Caracas, Venezuela, and Werner R. Rieter as export sales engineer in New York.

Storms, as merchandise manager for Continental-Emsco Company C.A., will have direct supervision of inventory and merchandise stocking for the three Continental-Emsco stores in Venezuela. Rieter will headquarter in the home offices of Continental-Emsco's Export division. The oil field supply and manufacturing company's Export Division is managed by H. E. Lowrey.

National Supply Company. R. Carson Allan, manager of Venezuelan subsidiary, has been transferred to the export division headquarters in New York City as area sales manager for Europe and Africa. He is succeeded by Lynn L. Leigh. Allen joined National Supply in 1938. He was transferred to the Export Division in 1947, where he became division engineer in 1952. He was appointed district manager in western Venezuela in 1954 and has served as manager in that country since 1956.

Charles A. McCollum will concentrate his efforts as area sales manager for the Middle East and Far East. He formerly acted also as area sales manager for Europe and Africa.

Howard C. Tait, area sales manager for Venezuela, has been transferred to Caracas as sales representative of the Venezuelan company. He is succeeded by C. E. Vandergrift.

McCullough Tool Company. Sales Representative W. S. Hemphill, formerly in Victoria, Texas, has been transferred to the Houma, Louisiana, location; D. B. Petty, sales representative, has been transferred from Wewoka, Oklahoma to McCullough's Hominy, Oklahoma branch office.

Koehring Company. Philip E. Cunningham, Milwaukee, has been named new product manager for the excavator line of Koehring Division, Milwaukee. Before his appointment he was employed by a construction equipment distributor in Wisconsin.

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A Guide to Books

Desert Enterprise, *by David H. Finnie. Published by Harvard University Press, Cambridge 38, Massachusetts. Pages, 224. Price, $5.*

Mr. Finnie's book came out at a good time to attract attention. His study of the Middle East oil industry in its local environment is all the better for being written in a calmer period. The book contains excellent background material, maps and photographs. It answers scores of questions that the new crisis has brought to the surface. (Also see editorial, Page A-4.)

Finnie, a lawyer, gathered his material as a Ford Foundation Fellow of the Center for Middle Eastern Studies at Harvard University.

This interesting observation is on the jacket flap: "Today the hot sun of the Arabian desert looks down on one of the most remarkable partnerships in world history. Here the oilman from the West and the Arab of the Middle East join in an alliance as uneasy as it is profitable to both."

Petroleum Sourcebook 1958, *published by National Petroleum Bibliography, Box 3586, Amarillo, Texas. Pages, 179.*

Curtis Stevens in Amarillo, Texas, is performing a service to the petroleum industry with his bibliographies. His latest is "Petroleum Sourcebook 1958," which is the first of an annual series designed to place in one volume the location of petroleum literature and data most often sought. The pages list material from more than 500 publications, including more than 80 periodical publications. Most of this material is of domestic origin and therefore easily obtainable.

References included in this book were compiled from the six 1957-1958 issues of the National Petroleum Bibliography which cover the year 1957. Only those listings which could be placed within a specific geographic area are employed. Thus, material of a non-regional nature is not included, but may be located in the parent work.

Listings include articles concerning all the states, the Canadian provinces, and countries and territories with oil activities or ambitions.

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A-2 More Interest on Your Training Dollar — *Carl Mullins White*
A-3 Industrial Relations in the Oil Industry — *Ray O. Weems Jr.*
A-4 Instruments and Control Equipment Directory for the Petroleum Industry
A-5 How to Write Better Technical Articles — *John L. Kent*
A-6 What Makes a Man Work? — *A. Q. Sartain*
A-7 You Can Buy It in S. A.—Directory of Supply and Service Companies in S. A.
A-8 Percentage Depletion — Hardly Anybody Understands It
A-9 Management's Real Job — PROFITS — *Edward J. Burnell*
A-10 How to Reduce Costs — *Benjamin P. Hamilton, Jr.*
A-11 12th Annual Report Survey — *Ernestine Adams*
A-12 Secrets May Be Stumbling Block

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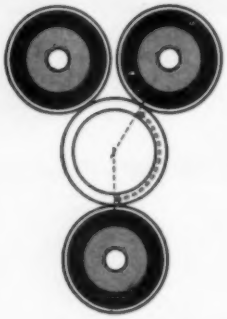

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National Manpower Council — Womanpower. *Published by Columbia University Press, Box 276, New York, New York. Pages, 39. Price, $5.*

This is a statement and recommendations by the National Manpower Council which was established at Columbia University in 1951 under a grant from the Ford Foundation. Objective of the Council is to study significant manpower problems and make recommendations.

Womanpower deals with women in labor force today and in business and industry. It shows trends in employment of women and discusses public policy issues.

We recommend this for departments that hire a number of women.

How to Become a Professional Engineer, *by John Constance. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. Pages, 288. Price, $5.50.*

Nearly half a million engineers still not licensed can benefit most from this just-published book; movements are now under way in most states to require all engineers to become licensed, the author points out.

Constance covers every step of the process in 16 practical chapters. He lists and clarifies the seven basic requirements for licensure; summarizes in plain terms the various state registration laws; and shows clear examples of how examining boards evaluate the experience of the candidate.

The book also explains how to prepare an application; gives pointers on selecting the qualifying experience and writing it up; shows how to prepare for written and oral examinations; points out what to look for in refresher courses; and tells how to achieve multiple-state registration.

The Oilman's Barrel, *by Robert E. Hardwicke. Published by The University of Oklahoma Press, Norman, Oklahoma. Pages, 122. Price, $3.75.*

In 1865 F. E. Hammond, of Miller Farm, Pennsylvania, was asked to figure the amount of oil contained in each vertical foot of certain oil tanks. Hammond prepared a table for one of these tanks, showing the amount of oil it would hold per inch from bottom to top, based on the amount of 42 gal per bbl. The table came into general use and this method of measuring tanks has never changed.

When the author, Robert E. Hardwicke, a Fort Worth, Texas, attorney associated with the oil industry, was in the Petroleum Administration for War, he asked his colleagues why American oil was measured by 42 gal per bbl and no other. It took him a dozen years to answer his own question, and now he has written a story full of lore of the oil gain of odd sized barrels and wagons for transporting petroleum in Pennsylvania; of Benedict Hagan, who supplied many an empty whiskey barrel to the producers; of Nelly Bly, who is called the "mother of steel barrels," and of the scientific struggle for accuracy in gaging oil.

You'll find this an entertaining and rewarding book. It would be especially suitable for getting off the press in 1959 when our 100th anniversary is celebrated.

Oil: From Prospect to Pipeline, *by Robert R. Wheeler and Maurine Whited; Gulf Publishing Company. Price $2.95. Pages, 115; 16 illustrations, Dictionary and Appendix; 1958.*

Intended as a concise account of oil operations for the laymen and oil company personnel. Covers the technical, economic, legislative, and competitive aspects of finding and producing oil, discussed under the following chapter headings: 1. Oil is How You Find It; 2. Drilling for Oil; 3. Getting the Oil to Market; 4. Who Owns the Oil; 5. What's It Worth; 6. Pride, Participate or Promote; 7. An Oil Dictionary; 8. Abbreviations Used in Oil Operations. The text is appended with useful tabulations including geologic nomenclature charts for the oil producing provinces of North America.

This book should be especially helpful to the rather departmentalized professional and clerical staff of the oil companies. Countless mineral owners and investors, as well as students considering a career in the oil business, should find the book useful.

Profit Perspectives in Atomic Energy — Problems and Opportunities, *published by American Management Association, Incorporated, 1515 Broadway, Times Square, New York 36, New York. Pages, 176. Price, $3.50 to members, $4.75 to nonmembers.*

This report is devoted to key management problems on atomic energy. It is a collection of papers from the American Management Association conference on "Managing the Atom" held in February. The conference was designed to help management meet the current problems on: (1) Return on investment; (2) government regulations; (3) hazards and their insurance, and (4) manpower and technology. The atom is a new and complex business and no effort should be spared in promoting a clear understanding of the problems involved.

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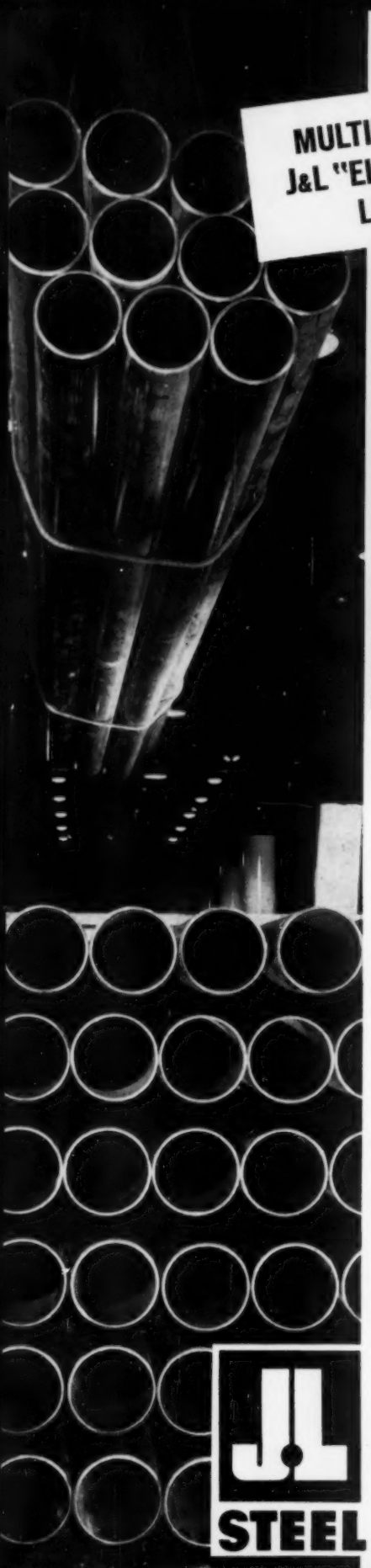

MULTIPLE-TESTED J&L "ELECTRICWELD" LINE PIPE

Welders on this Jayhawk Pipe Line Company installation report J&L Electricweld pipe is easy to weld. They installed 3109 tons of 10¾-inch O.D. and 3172 tons of 12¾-inch O.D. Electricweld pipe in this line. Both sizes are in .250 inch wall and Grade X46.

Jayhawk relies on J&L "Electricweld" line pipe for 78 miles of dependable performance

The Jayhawk Pipe Line Company, Wichita, used 42 miles of 10″ and 36 miles of 12″ J&L Electricweld line pipe in this new line from Plains to Valley Center, in Kansas. They find that J&L Electricweld line pipe bends readily, is uniformly round, is consistently top quality.

Electricweld line pipe is produced by Jones & Laughlin under most rigid quality controls. J&L, an integrated steel company, is able to control quality from ore through finished pipe. J&L takes every step to assure unsurpassed quality and dependability in Electricweld.

Before welding, the skelp edges are blasted with steel grit under 100 psi in a "Vacu-Blast" unit to clean the surface for perfect contact with the welding electrode. Electronic controls maintain exact welding heats at all speeds. After welding and trimming, the pipe passes through an induction annealing unit to assure uniform grain structure in the weld area.

Every length is thoroughly inspected through visual examinations, hydrostatic tests, flattening tests and magnaflux examinations. All J&L Electricweld line pipe is manufactured and tested in strict compliance with appropriate A.P.I. and A.S.T.M. specifications.

Electricweld line pipe is available from 6⅝ inches through 12¾ inches and in lengths to 60 feet. Investigate this superior-quality pipe for your next line. See your distributor, or write to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pa.

J&L STEEL

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CRADLING IN NEW YORK — Bechtel Corporation uses its MD7 for cradling operations on a steel gas line. The company has used Cat Pipelayers for a long time. They have enough reserve power to keep going under really heavy loads.

PIPELAYING IN CALIFORNIA — The MD7 lowers in a 16-inch steel gas line for Underground Construction Co. & Stolte Inc. "Cat-built Pipelayers are reliable and the 24-hour parts service we get is a big boon for us," says Project Engineer R. E. Hall.

DRILLING IN ARIZONA — Here Cape Construction Co. uses its MD7 for a drilling operation on a 24-inch crude oil line, running from Four Corners to Los Angeles. In rough going, pipe is being put in the ground at a rate of 2 miles a day. "We rely on Cat-built Pipelayers to get the job done," says Garland Mims, spread superintendent.

Wherever the pipe takes you, the MD7 is ready for action

The Caterpillar MD7 Pipelayer is an all-around machine that comes to *work*—and the harder the work the better.

This big yellow unit is used for unloading and stringing, pipelaying, cradling and—equipped with a bulldozer—can even help backfill. But just as important as the many jobs it can do is the deft, dependable way it handles them.

The MD7, with 128 HP at the flywheel, has a 54,200-pound lifting capacity. And it was engineered to take full advantage of its power. For instance, hydraulically actuated counterweights are available to quickly adjust the lifting capacity to job needs. And no matter how rough the going, seven-roller track frames and 22-inch track shoes can give the machine excellent stability and flotation. No matter how low the temperature, the MD7 will be ready to work when you are because of its positive, dependable starting. Its powerful diesel engine is pre-conditioned by a Caterpillar gasoline starting engine.

For precision work, hydraulic steering boosters give you the accuracy and dependability of manual control without the hard work.

These features have been engineered into the MD7 to help you cut costs. So see your Caterpillar Dealer for complete details. The quicker you see him, the sooner you will start saving money.

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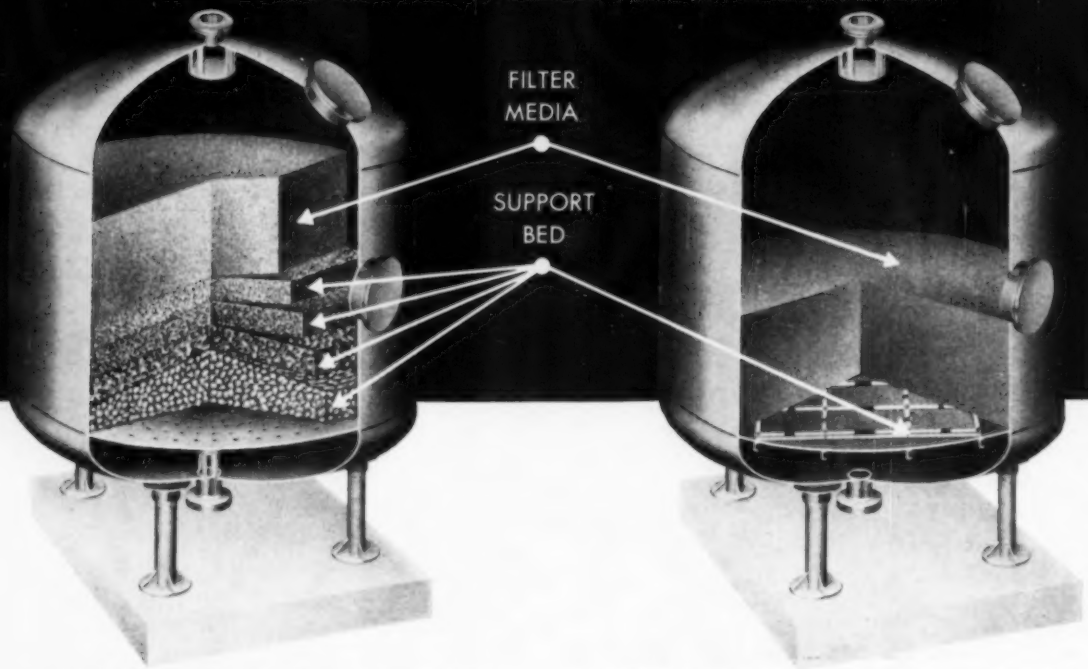

NATIONAL'S MULTIPLE ORIFICE BED PLATE DESIGN WITH MULTIPLE GRADED BED.

NATIONAL'S PERMEABLE BED PLATE DESIGN WITH SINGLE FILTER BED.

POINTS OF COMPARISON

CAPACITY: (The same in either type with comparable filter-media and operating conditions) Filtration capacity of Rapid Mechanical type filters (either type shown) is affected by fineness of top layer filter bed media, and porosity of filter cake collected on the bed. **Supporting Structures merely support the filter-media beds and neither one affects the capacity of the filter.**

PRESSURE DROP: (Essentially the same in either type) Within the operational capacities of either type filter, the pressure drop thru clean filters after backwash cycle is less than six (6) inches of water. Pressure drop increases with fineness of top layer of filter bed media and filter cake deposition.

BACKWASH RATES: (The same for either type when the filter-media is the same material) Backwash rates should be ample to expand the fine media section by at least fifty (50) per cent. **Supporting structures are not disturbed at such rates.**

QUALITY OF FILTERED WATER: (The same thru either unit when using same filter-media) Quality of water is associated with filtering ability. Filtering ability has to do with fineness of top layer filter bed media and porosity of filter cake. The finer the media, the better the quality of water. **Supporting beds have no measurable effect on the quality of water.**

ECONOMICS OF THE TWO TYPES: This is best determined after knowing the type media to be used. The permeable bed plate type filter (Illustration Right) can be fabricated with a shorter overall vessel height. If this is of prime importance then that is the controlling factor and not the related media costs. Usually, the first costs and up keep of the graded bed type are less.

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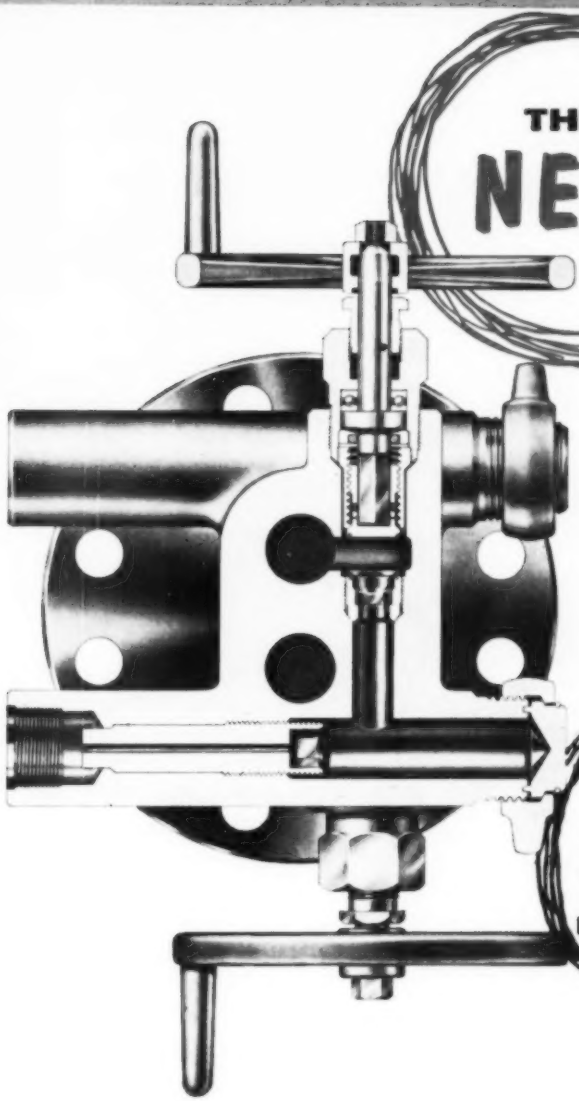

35% LESS COST

50% LESS WEIGHT

Numerous advantages are inherent in the simplicity, economy and efficiency of the O-C-T Dual Port Flow Control.

• Cost savings of 35 per cent over conventional wing model. • Weight savings of 50 per cent over conventional wing model. • Compactness. • Minimum of connections. • Leak-proof operation. • Bottom hole test adapter connections provided. • Single flow control advantages maintained. • Standard parts interchangeable with O-C-T single flow controls.

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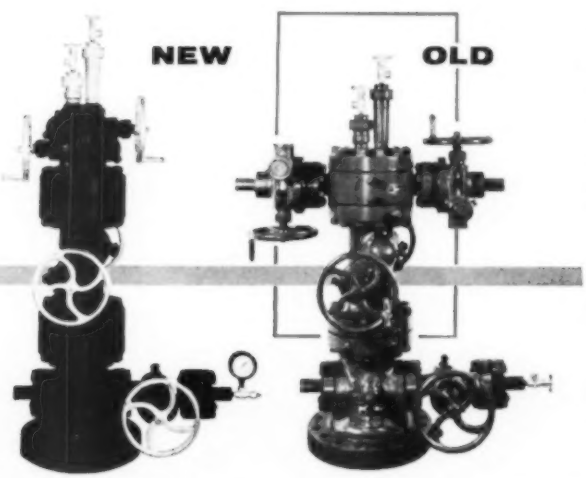

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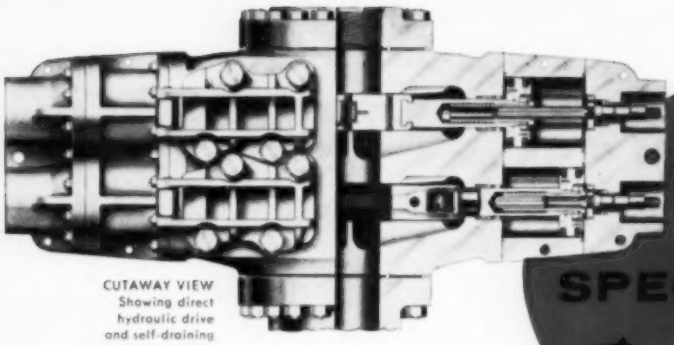
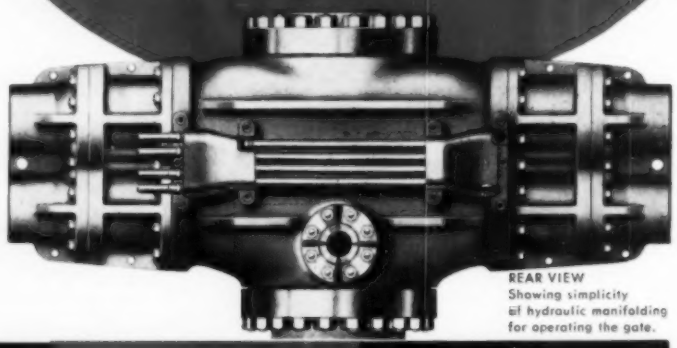


CUTAWAY VIEW
Showing direct hydraulic drive and self-draining ram compartments.

for UTMOST VALUE in Cellar Control Gates — SPECIFY — and GET — These SHAFFER Features



REAR VIEW
Showing simplicity of hydraulic manifolding for operating the gate.

There is a big difference in cellar control gates. And to fully appreciate that difference, compare the important advantages you get in Shaffer Hydraulic Gates with the features of any other similar equipment. You'll find that Shaffer tops the field in advanced engineering... in actual performance... in basic value received per-dollar spent. So to make certain you get the best in cellar control gates, specify—*and make sure you get*—these Shaffer advantages...

specify CONVENIENCE!

Rams must be changed frequently during the life of a well, and no other unit equals Shaffer in ease of changing rams. Simply open two doors in the side of the gate, slide out the ram assembly, change rams, slide the assembly back in place and bolt the doors. Closing the doors automatically aligns the rams for proper operation.

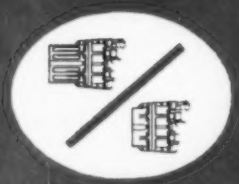
What's more, Shaffer rams can be changed with equal ease whether the pipe is in or out of the hole!

specify COMPACTNESS!

Again its Shaffer, because Shaffer Gates are not only unusually compact, *but no extra space need be allowed for expanding the gate to change rams.*

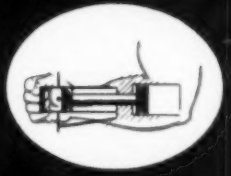
Even in sizes as large as 13⅝" (12"-Series 900), Shaffer Double Gates require only 30" height—Single Gates only 18½"...smaller sizes even less. And length and width dimensions are equally compact!

specify ADAPTABILITY!



Once again its Shaffer, because you get the type of locking shaft YOU prefer. Some operators like the extra compactness of a *Non-Rising* Shaft. Others like the quick indication of ram position they get with a *Rising* Shaft. Take your choice with Shaffer because Shaffer provides both types. And both have built-in body extensions to protect the shaft against damage!

specify POSITIVE DRIVE!



When emergencies threaten you want quick, positive closing action in your control gates. And you get it from Shaffer because the operating cylinders are *directly behind* the rams. There are no yokes, no complex connections between piston and ram. Therefore, you not only get greater dependability, but also fewer parts, simpler maintenance!

There are many other "Extra Value" advantages built into Shaffer Hydraulic Gates... such as *Completely Enclosed Design* (no exposed moving parts), *Self-Draining Compartment Bottoms* (no detrimental mud and sand interferes with free ram travel)—and still others. Get the complete story from your nearest Shaffer representative—or write direct!

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See the Shaffer Section of your Composite Catalog!

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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35 years OF OIL TOOL LEADERSHIP!

Of Things To Come . . . In Oil

TOMORROW'S PAYOFF FOR TODAY'S RESEARCH will soon sift through — and will be one of the primary factors in strengthening future economy of the nation. Money being spent in oil research is "money in the bank" for tomorrow's oil industry. With billions now being channeled in that direction, "we may find 20 years from now that half of our working population will be producing and selling things now unknown to us," says J. Allen Walker, general credit manager of Stancal.

ARGENTINA WILL BE AN OIL EXPORTER IN SIX YEARS, if agreements are fulfilled according to desires of Argentine President Frondizi. New oil program, with government-owned YPF as prime agent, will be aided by several U. S., German, and Russian concerns. A group made up of Atlas Corporation, Hidden Splendor Minerals, Petroatlas, Williams Brothers, Mid-Continent Exploration and Ferrostaal AG (German) have agreed to put up $700,000,000. Pan American International has signed contract for finding, drilling and moving oil; Conorada has offered $100,000,000 for exploration. Russia hopes to sell $100,000,000 of oilfield equipment to Argentina.

MIDEAST HAPPENINGS ARE KINDLING AN ALASKAN OIL FIRE that may not need additional governmental "fanning" if current wildcats are successful. With leasing bans lifted, work is expected to get underway. More than 5000 leases are already on file to be processed. T. A. Zappa, president of Alaska Oil & Mineral, has asked for a "crash program." Michel Halbouty, Houston independent, just returned from his 1,250,000-acre Alaska holdings, declares that "One or two more fields (like Richfield's discovery) will set off a boom which will make Spindletop, Eldorado, East Texas, Burkburnett, and Ranger pale into insignificance."

AN 'FPC' FOR CANADA is a near-certainty as a result of investigations conducted by a governmental agency known as the Borden Royal Commission. This group, charged with reviewing the Dominion's energy requirements and potentialities, would set up an energy regulatory body similar to the Federal Power Commission in the U. S. Most oil industry observers reluctantly foresee "probability" of such a group. Each province now administers its own natural energy resources regulations.

FARMOUTS FOR U. S. COMPANIES IN MEXICO? Such deals may soon be clarified by Antonio Bermudez, head of Pemex, Mexico's national oil company. Rumors persist that Bermudez will voice "exploration opportunities available for American operators" before Society of Exploration Geophysicists convention in San Antonio, Texas in October. Several geological and geophysical papers on Mexico are definitely committed by Pemex.

GETTING CORRECT RING FIT IS EASY WITH

.... Martin Plungers and the Martin Method of Installation*

The rubber-and-duck rings swell **just so much** and no more.

Rings reach maximum size in the well within a few hours.

Dimensional Compensation during the manufacturing process assures the uniform working fit obtained with Martin Split Rings.

The Martin Ring Size Guide Table* assures proper ring size selection for various gravities, temperatures and sand and water content.

Martin Split Rings are made in steps of .005" in diameter, so that you can actually increase or decrease plunger clearance that amount by changing to next larger or smaller size.

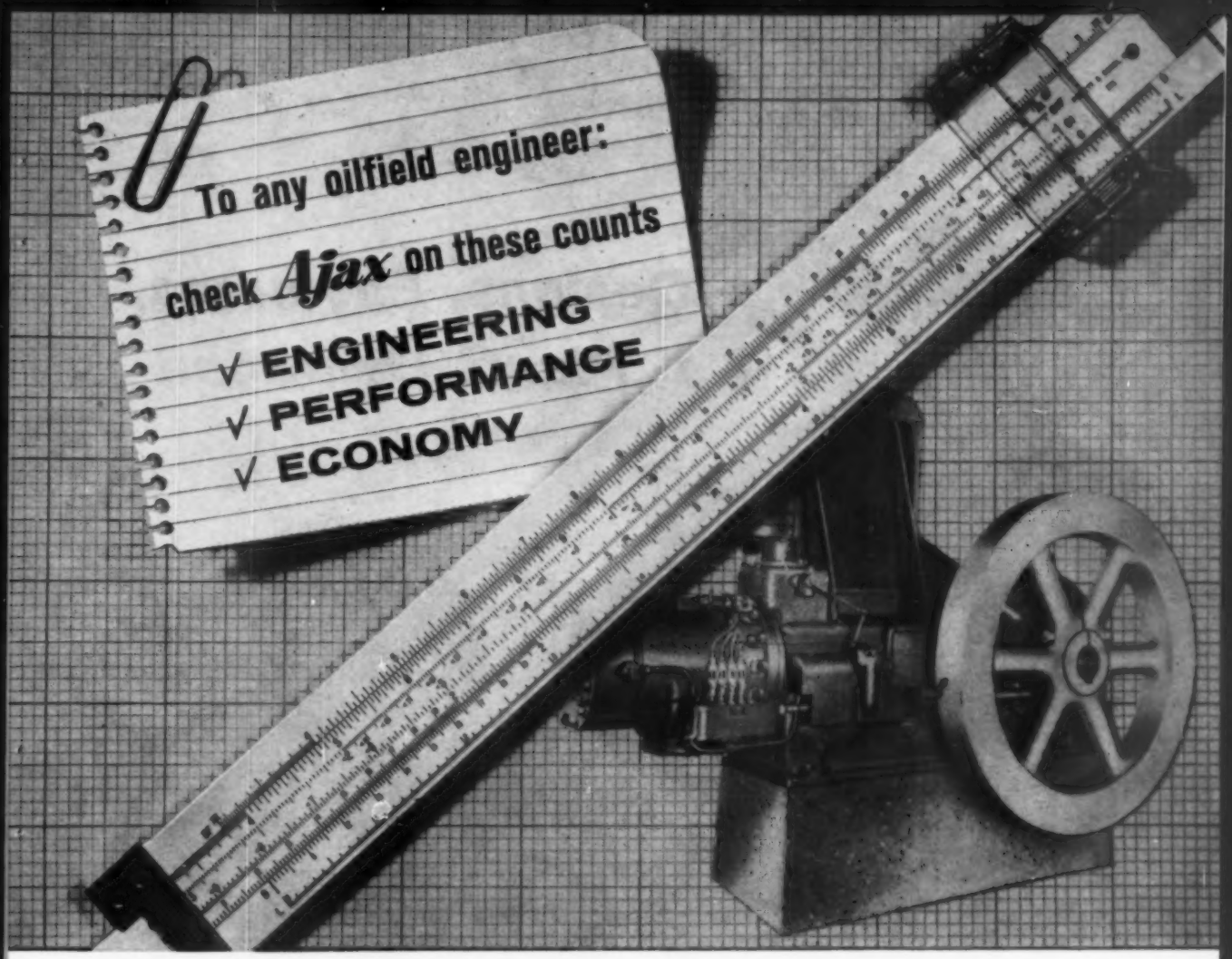
The gaps between the Martin Rings cause fluid turbulence which slows down slippage past the Martin Plunger — just as a rough road slows down your driving speed. Actually, the Martin Plunger maintains pumping efficiency with a looser fit than is possible with a smooth surface plunger.

* See the complete Martin Catalog and instructions in the 1957 Composite Catalog.

JOHN N. MARTIN

Manufacturer

9 W. BRADY • TULSA, OKLA.



...and discover that the soundest gas engine concept is the simplest and most efficient in practical results

The 2-cycle gas engine, an integral part of oil production since the very beginning, is as *new as today* when it bears the AJAX nameplate. In the past decade the Ajax program of continuous, creative engineering development has brought the 2-cycle engine fully into its own—delivering greatly increased horsepower for the same bulk—economy far outrunning any other type of prime mover—continuous, unsupervised operation for months on end if need be—and *maintenance as low as Ajax life is long.*

● For the rugged jobs, the 2-cycle engine gets the call. For top quality performance, call on Ajax! Your Supply Man will be glad to oblige.

GAS ENGINES AJAX SINCE 1877

Ajax IRON WORKS

Builders of GAS AND OIL ENGINES · PRESSURE PUMPS

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA. · R. B. MOORE SUPPLY CO., BOLIVAR, N. Y. · BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

Southwest Designs, Engineers, Plants Using the

and Builds Packaged Compressor
Compressor You Select

Now to the advantages of Southwest design and engineering you can add flexibility of choice by selecting your own make and type compressor in sizes of 100 to 880 hp. You have the sound advantages of proved Southwest engineering. There is no increase in your parts inventory. There is no training period to familiarize your personnel with a new make compressor. Yet, you can have the vastly improved and superior Southwest design for your packaged gas compressor.

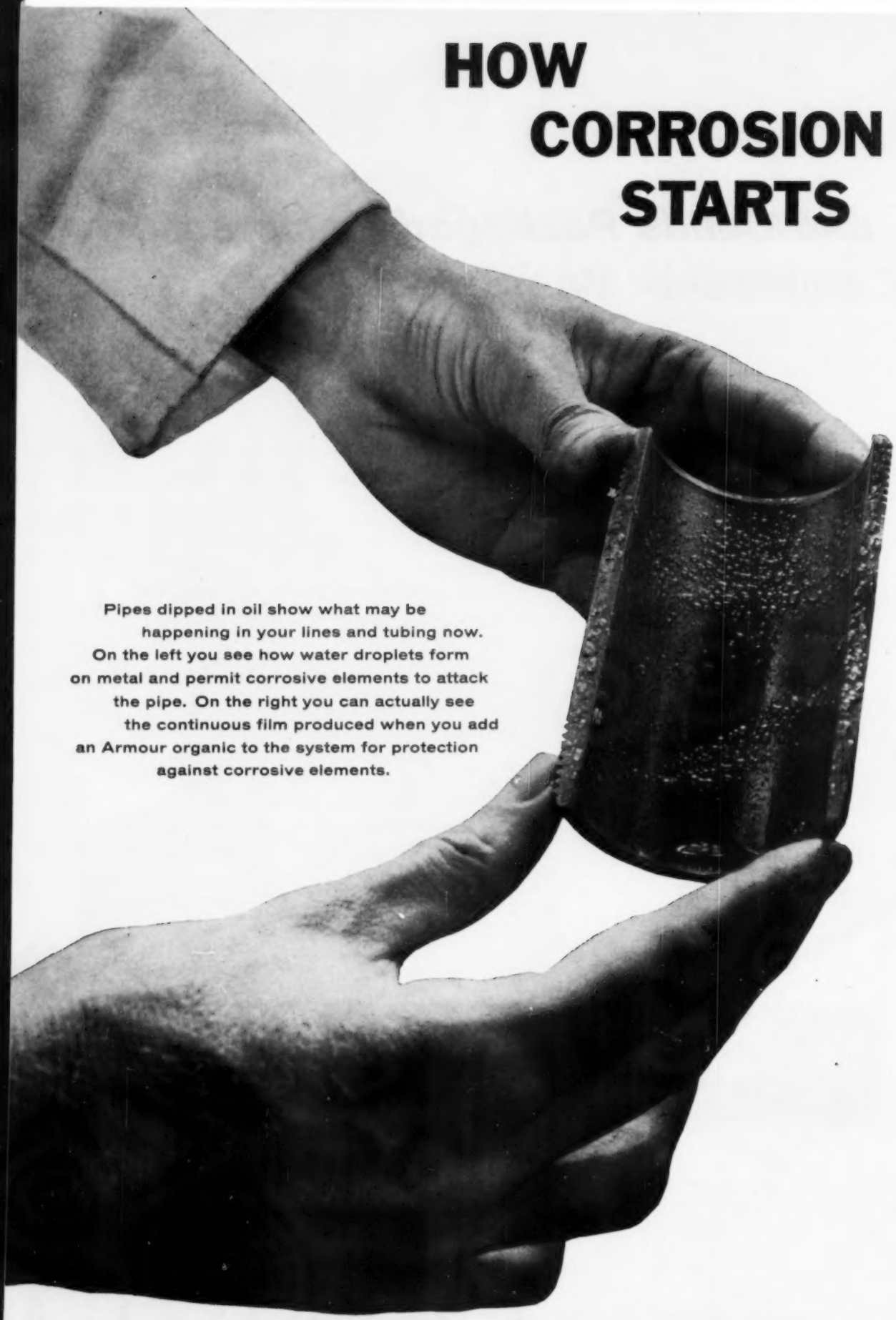
Southwest Packaged Gas Compressor Plants installed in the field are now producing more than 100,000 horsepower—compressing more than 1½ billion CF/D—for field pressure boosting, main line gas pipe line pumping, secondary recovery, and other difficult applications.

SOUTHWEST INDUSTRIES, INC.

P. O. Box 19392, Houston 24, Texas

Designers and manufacturers of Packaged Inert Gas Generators, Packaged CO_2 Removal Units, and Packaged Gas Compressors.

HOW CORROSION STARTS



Pipes dipped in oil show what may be happening in your lines and tubing now. On the left you see how water droplets form on metal and permit corrosive elements to attack the pipe. On the right you can actually see the continuous film produced when you add an Armour organic to the system for protection against corrosive elements.

HOW ARMOUR ORGANICS STOP IT

Duomeens® and Arquads® form continuous films. They lock out water and corrosive elements—give up to 99.5% protection.

In primary and secondary oil recovery operations, Armour organic chemicals offer unmatched protection against corrosion. As little as 10 ppm protects pipes and equipment—above and below ground.

Duomeens and Arquads protect against the corrosive effects of brine, hydrogen-sulfide and other corrosive elements. Because they adsorb continuously on metallic surfaces, Armour organic chemicals are lengthening the life of pipes and equipment, and cutting replacement costs in many oil fields.

• • •

There are variations of these basic Armour inhibitors. Each has characteristics useful in specific applications. They are effective at about 10 ppm in water-flooding, or at about 50 ppm when used as down-the-hole inhibitors, (basis: 100% activity).

Duomeen CD-50: Effective corrosion inhibitor in all water systems. Completely dispersible in water. **Duomeen CDA-50:** Used in systems where carbon dioxide and oxygen corrosion are a problem. Water soluble. **Arquad T-2C:** Particularly effective in fresh water systems. Ranges from water soluble to dispersible. **Armac CD-50:** Especially effective in fresh water systems and low sulphate brines. **Duomeen TDO-50 (Liquid):** An easy to use, oil soluble, water dispersible, down-the-hole corrosion inhibitor. Utilized to inhibit corrosion in salt water disposal systems. **Duomeen TDO (Fluid paste):** 100% active, oil soluble corrosion inhibitor, also used in salt water disposal systems.

Duomeen TDO under varied test conditions

	Control	With Additive	Gals. per 1,000 bbls.**
ASTM Turbine Oil Test	Heavy corrosion	No corrosion	1.7
Revolving Wheel Test H_2S saturated brine-kerosene	39.6 mpy*	3.8 mpy	2.1
Salt Water Disposal System Test Coupons installed at well heads	15 mpy	.5 mpy	0.2

*Mils penetration per year **Basis, 100% Activity

For product samples and descriptive literature on treatment procedures, and applications information for any of these Armour organics, simply write us on your company letterhead.

ARMOUR CHEMICAL DIVISION

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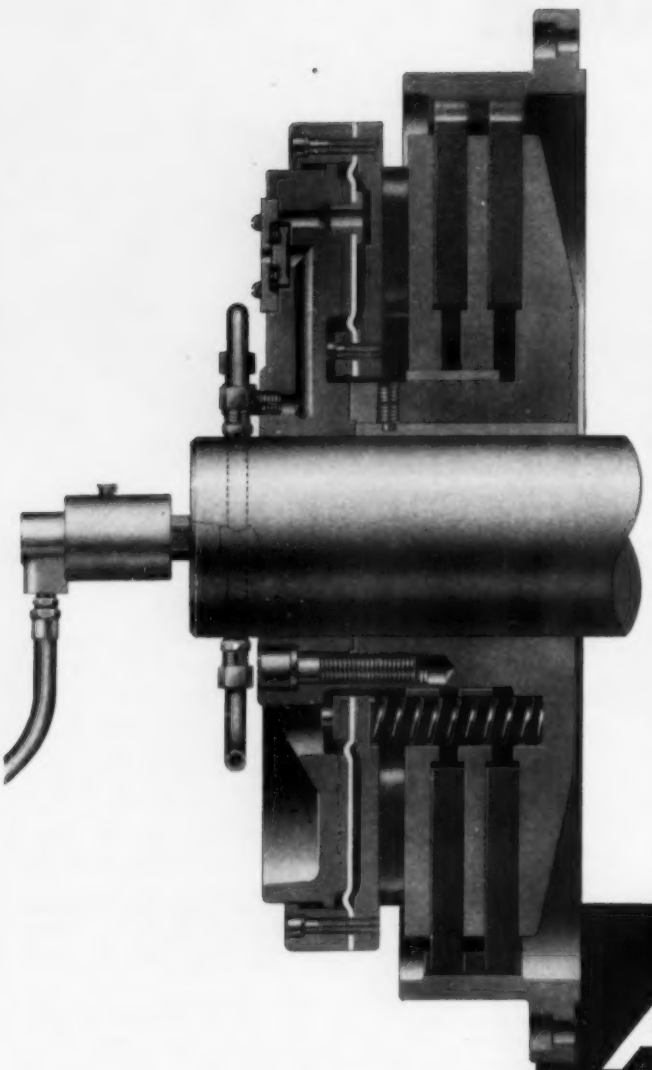
Armour—Leader in progressive fatty acid chemistry



1. Quickest acting, most responsive air clutch available!
2. Finger tip control!
3. Built-in quick release valves! (Optional)
4. Requires minimum volume of air!
5. No adjustment necessary!
6. Internally ventilated — cooler operation!
7. Operates at air pressures up to 140 psi!
8. Most compact!
9. Interchanges with and can be used to replace Dodge or other mechanical clutches in existing installations.
10. Available from stock in single and double plate types. Capacities from 8.5 to 460 hp at 100 rpm at 80 psi.

AIR-GRIP

NEWER! BETTER!

DODGE

of Mishawaka, Ind.

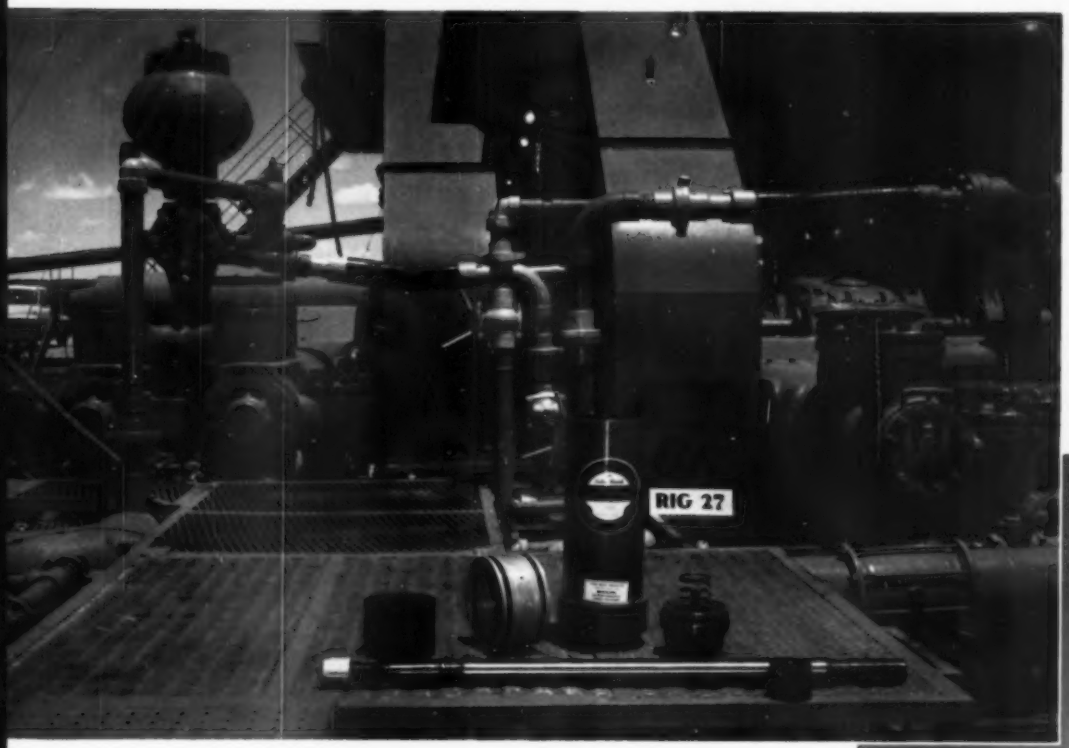
CALL THE TRANSMISSIONEER —your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone book for "Dodge Transmissioneer."

This air clutch, engineered to modern needs, provides maximum torque capacity in minimum space. Its operation requires less air, resulting in amazing sensitivity. It gives the operator split-second control—from "inching" to full engagement. Quick-release valves are built into the clutch itself, as optional equipment, for instant disengagement where such service is required.

The unique design of Air-Grip places the air seal disc at the end *farthest* from the pressure plates, which generate the heat inherent in clutch action. This combined with automatic internal ventilation, insures cooler operation and longer life under severest service. Call your local Dodge Distributor, or write for Bulletin.

DODGE MANUFACTURING CORPORATION, 7900 Union Street, Mishawaka, Indiana

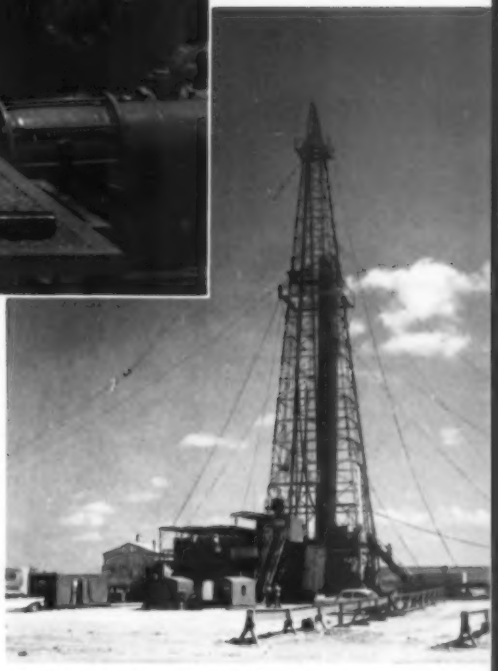
How MISSION pump parts helped "drill" the world's deepest well before it was even spudded!



Long before the Phillips Petroleum Company's 1-EE University started drilling, Mission research engineers had already designed and tested, in Mission's own mud pump laboratory, the vital pump parts that helped carry this well to its new world's record.

Under simulated extreme conditions that could be anticipated in drilling to 25,000 feet, the Mission Rods, Liners, Valves, Pistons, Liner and Gland Packings that figured in this remarkable drilling achievement passed all tests like the champions they are.

The drilling of the Phillips Petroleum Company's 1-EE University is not only a tribute to the pioneering spirit of the Phillips Petroleum Company, it emphasizes again the foresight and ingenuity of the oil tool manufacturers and technical services fraternity who are partners in petroleum progress.



Phillips Petroleum Company's 1-EE University in Pecos County, Texas.

Nothing but the finest will bear the name of **MISSION** MANUFACTURING CO

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PUMP VALVES AND SEATS • SWABS • VALVES • HAMMERDRILS • CENTRIFUGAL PUMPS

GRANT 3-BLADE WALL SCRAPER

This Meeting of **GRANT SPECIALISTS** *was Important to* **YOU!**

There is nothing in the field today to equal the Grant 3-Blade Wall Scraper for positive, controlled scraping under the toughest hole conditions.

But the Grant Wall Scraper was no overnight development. Grant men in the oil patch, in engineering and in manufacturing contributed their own highly specialized knowledge and long experience solving oil field problems to design, build, test and perfect this tool for you.

Specialization in down-hole equipment for over 30 years is just one more reason why you can steadily look to Grant for tools to help you drill wells *better*, for less.

Write for Bulletin 60

GRANT
OIL TOOL COMPANY

Main Office and Plant:
2042 EAST VERNON AVENUE, LOS ANGELES 58, CALIFORNIA

AVENAL, BAKERSFIELD, COMPTON, VENTURA, WILLOWS, CALIFORNIA • HARVEY, HOUMA, LAFAYETTE, LOUISIANA • LIBERAL, KANSAS • FARMINGTON, HOBBS, NEW MEXICO • NEW YORK, NEW YORK • OKLAHOMA CITY, OKLAHOMA • HOUSTON, ODESSA, TEXAS • CASPER, WYOMING

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

GUIBERSON'S FULL RANGE
of High and Low Pressure, Quick Change
UNIONS

1,000 lb. test
2,000 lb. test

4,000 lb. test
6,000 lb. test
10,000 lb. test
15,000 lb. test

Quick and easy to make or break, Guiberson's Unions are ideal for a multitude of uses... give a positive, leakproof seal, with minimum upkeep. Guiberson's low pressure unions 1" through 10" sizes have metal to metal seats, feature a convenient 3-lug wing nut.

High pressure unions are made in 1" through 4" sizes. 6,000 lb., 10,000 lb. and 15,000 lb. unions incorporate the pressure-molded Seal-O-Matic Ring. All high pressure unions are forged steel.

THE
GUIBERSON
CORPORATION

ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

Sold by
Oil Field Supply Stores
Everywhere

Two of Jess Edwards' Macks unloading at drilling site near Farmington, New Mexico.

Supply line to the oil fields

Pushing overland through mud, sand and swamps, loaded with drilling rigs, draw works, casing and other heavy oil field equipment—it's all in a day's work for the truck fleet operated by Jess Edwards, Inc., of Corpus Christi, Texas. And Mack's ability to get through—no matter what the weather or terrain—has made them Jess Edwards' choice for this tough service.

The extra quality built into every Mack really shows up in rough overland hauling. Their extra-strong frames and chassis shrug off jolt and shock. And they can be operated in all weather, over all terrain, because Mack's exclusive Balanced Bogie with Power Divider provides torque to the axle and wheels with the best traction.

Edwards also has found that the low down time of the Macks means they are on the job all day long, month after month, hauling more profit-making payloads with time out for only routine servicing.

Your Mack distributor will be glad to show you on-the-job proof of Mack's superior performance record. Remember—whatever your hauling operation—Mack makes a truck that's right for you. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK

first name for

TRUCKS

5848

MILLIONS OF STOPPERS

against fluid loss . . . thousands of feet below!

There's a real guard against fluid loss when fracturing fluids are treated with Adomite. Its millions of tiny particles temporarily seal the pores of the matrix rock. This means that fluids can be injected under greater pressures, at higher injection rates . . . and it means more profits, too! Adomite makes it possible to get an extended, deeper fracture . . . with minimum sanding out.

Adomite leaves no permanent seal on the fracture wall. There is no evidence that the formation has ever been sealed. And here are other important reasons why more producers *standardize* on Adomite:

- Obtains larger fractures per volume of treatment, or the same-sized fracture with a lesser volume of fracturing oil.
- Decreases friction loss because of the low viscosity of Adomite-treated fluids.
- Utilizes your own lease crudes . . . saves transportation costs.
- Assures acceptance by the pipeline companies for Adomite-treated lease crudes.

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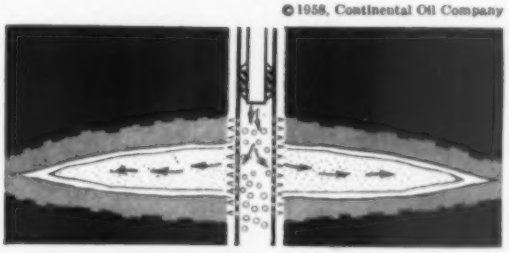
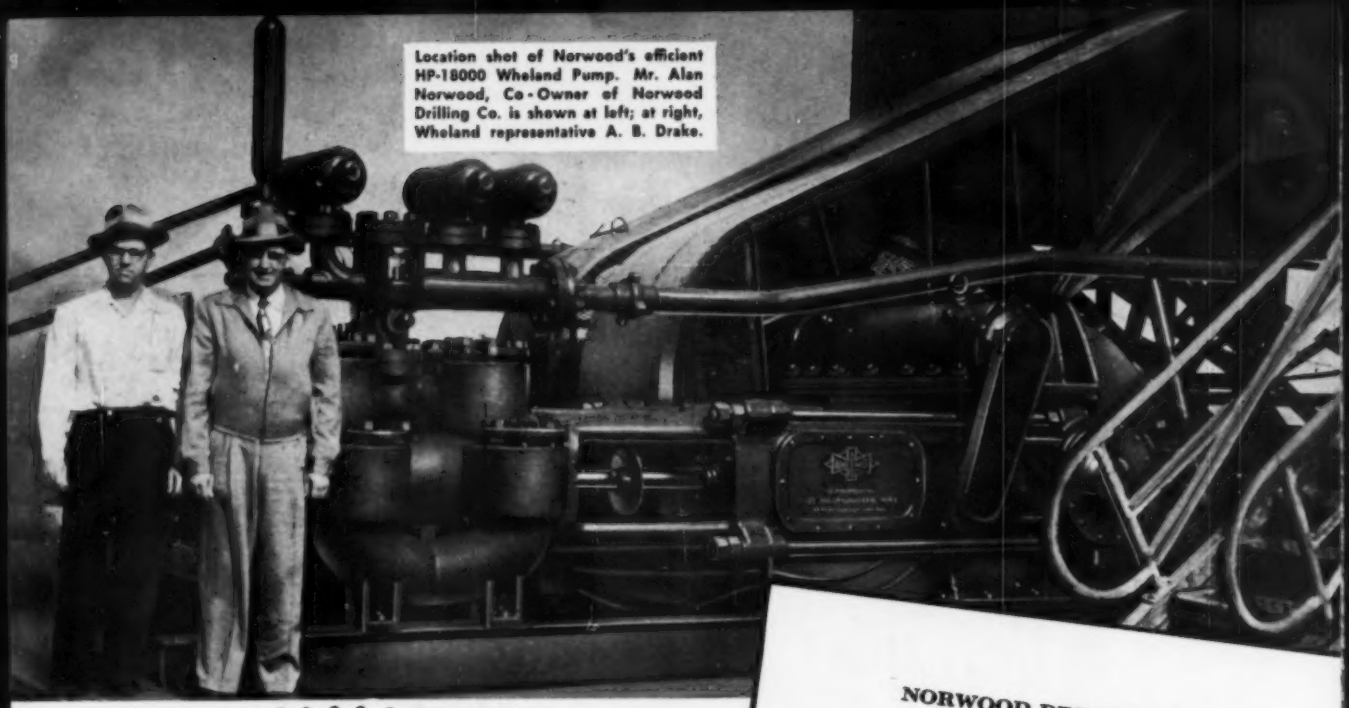


For greater profits . . . fracture with

ADOMITE®



Location shot of Norwood's efficient HP-18000 Wheland Pump. Mr. Alan Norwood, Co-Owner of Norwood Drilling Co. is shown at left; at right, Wheland representative A. B. Drake.

PERFORMANCE!

". . . has fully met our expectations on performance . . ."

"have had no expense on this pump"

WHELAND HP-18000

DUPLEX SLUSH PUMP

7¾" x 18", 750 HP Nominal Input at 60 RPM.
Discharge Pressure with 7¾" liner, 1322 PSI;
Discharge Pressure with 5½" liner, 2700 PSI.

BULLETIN ON REQUEST

NORWOOD DRILLING CO.
WICHITA NATIONAL BUILDING
WICHITA FALLS, TEXAS

January 21, 1958

Mr. Gordon P. Street
The Wheland Company
Signal Mountain Road
Chattanooga, Tennessee

Dear Mr. Street:

We operate six rigs in West Texas and New Mexico area; depths range from 5,000 feet to 14,000 feet.

The Wheland HP-18000 pump we bought more than a year ago has been in the West Texas area working on wells between 10,500 feet and 13,500 feet. It has fully met our expectations on performance and so far we have had no expense on this pump.

Yours very truly,

NORWOOD DRILLING COMPANY

By: Alan Norwood
Alan Norwood

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

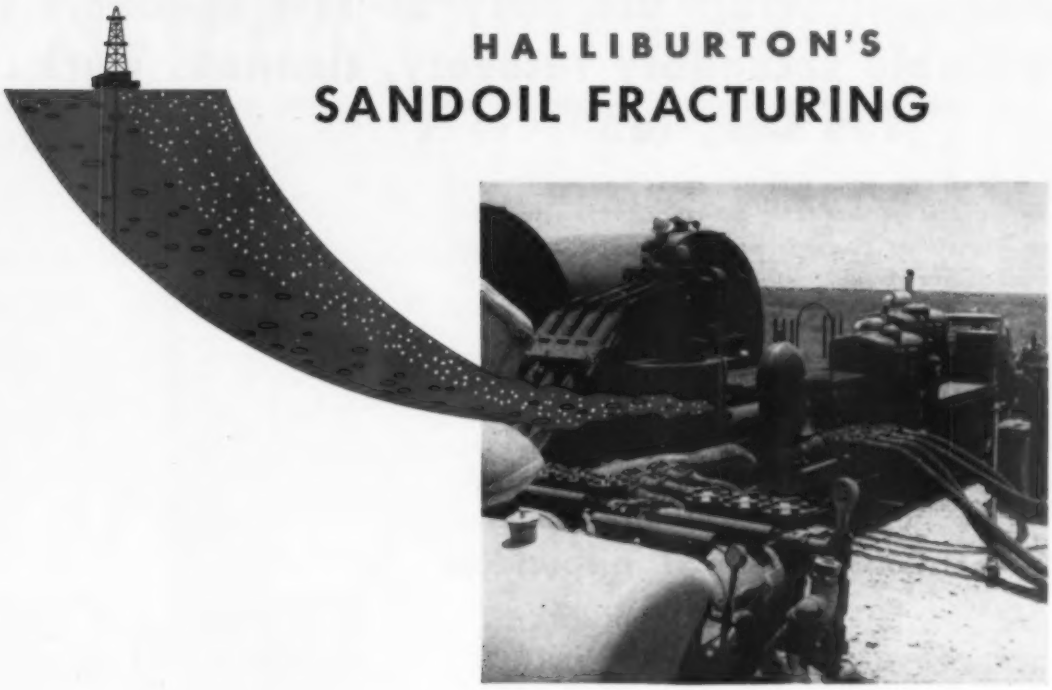
DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas • JONES-AND LAUGHLIN STEEL CORPORATION, SUPPLY DIVISION—Main Office: Drawer 2481, Tulsa 2, Oklahoma.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

economical for small jobs, too

HALLIBURTON'S SANDOIL FRACTURING



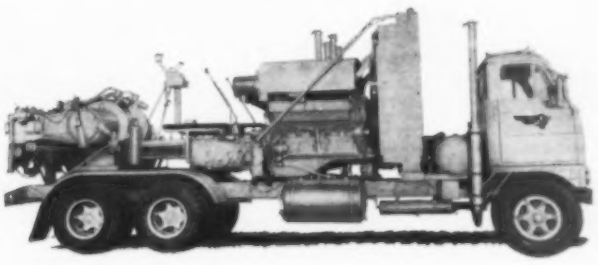
The fact that SANDOIL fracturing is economical for big volume jobs means that comparable economy is also possible where smaller volumes of fluid and propping agent are required. Inexpensive, readily obtainable crude or refinery cuts and blends are used for the fracturing and carrying fluid. Emulsion problems are minimized by chemicals that can precede, follow or be mixed with the fracturing oil.

You need pay no premium for big units on small volume jobs. Halliburton's specially designed pumping and continuous proportioning equipment is sized to the job. That's another reason why you save with Sandoil fracturing.

Continuous proportioning at well site permits rigid control of sand ratios and fast, high horsepower pumps provide optimum controlled injection rates at desired pressures.

For big or small volume fracturing, Halliburton's Sandoil process can save you money... and increase production profitably. It will pay you to discuss it with your Halliburton representative. Call the local or district office or write the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

Ask for new revised "Elements of Hydraulic Fracturing"



HALLIBURTON

OIL WELL CEMENTING COMPANY

PIONEERS IN FRACTURING SERVICES

JUST MINUTES AWAY FROM ANY RIG

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

These contractors use Bucyrus-Erie spudders for profitable secondary recovery, cleanout work . . . You Can, Too

These men profit from the speed and mobility of Bucyrus-Erie spudders. They get forward and reverse speeds on all reels and on the catheads for accurate, split-second control; free-wheeling reels for quick lowering; fast, powerful line pulls for easy handling of tools, packers, swabs, and tubing; and mobile design for time-saving moves.

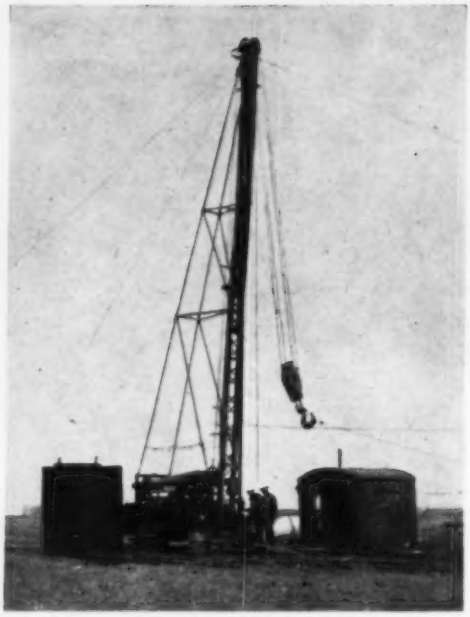
Check the jobs pictured of today's popular choices for well servicing and secondary recovery — the 60-L, 28-L, and 36-L spudders, available for skid or trailer mounting. Then visit your nearby Bucyrus-Erie distributor or write us direct for all the facts.

55558

FIRST with the FINEST in spudders

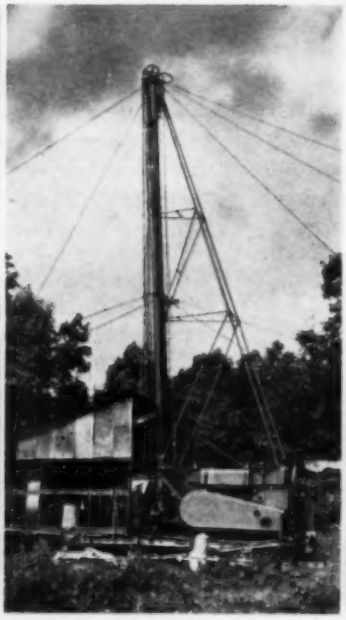
BUCYRUS ERIE

BUCYRUS-ERIE COMPANY, DRILL DIVISION
U. S. Highway 40 West, Richmond, Indiana



A 60-L owned by Gaines Drilling Co., El Dorado, Kans., cleans out a 1900-ft. well (about 40 years old) in a Cities Service water flood project west of El Dorado. Says Driller Mack Gaffney: "I like 'em. Bucyrus-Eries have a good snappy spudding motion." Driller Harley Nicholas adds: "I've worked a lot of rigs in different formations all over the country . . . and I like Bucyrus-Eries for their steady, trouble-free performance."

Owners of five Bucyrus-Erie spudders, Greer Bros., Whitesville, Ky. consider the 60-L as "the only rig for drilling in Kentucky". This 60-L is cleaning out a well in the Apex Field near Greenville. High line speeds assure rapid progress on hole after hole. Mobile trailer mounting, telescoping derrick, and folding tubular braces save time of moves.

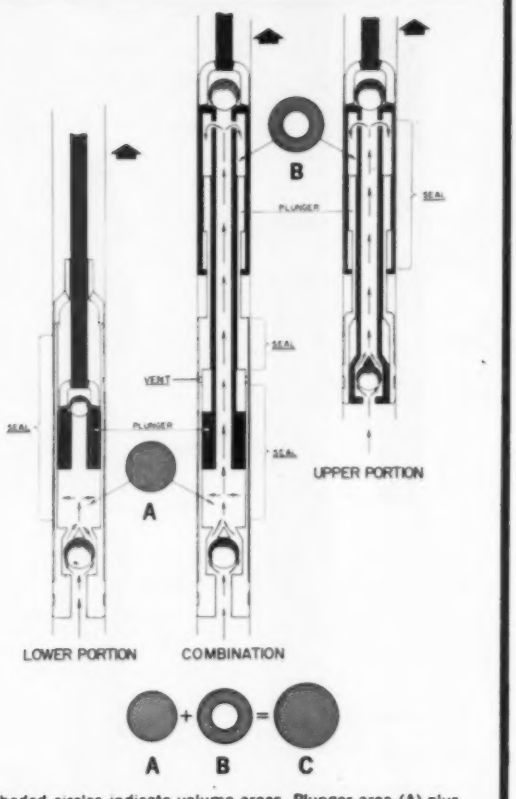


A Halliburton crew runs a Hydrofrac to increase the gas flow from a 3,113-ft. well in west central Pennsylvania. Joining in the operation, Ed E. Hess, Clarion, takes advantage of the speed, strength, and capacity of his 36-L to set casing, handle tubing, and run treatment packers.

"We had all kinds of equipment," says E. M. Hale, Ada, Okla., "but we've standardized on 28-Ls for quick moving. We worked over 23 wells in six months on a water flood project with never a breakdown for either rig." Hale (extreme right) watches his men swab fracture oil and fresh crude through perforations on a well in the Wetley Field.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW AXELSON VOLUMAX INCREASES PRODUCTION FLOW



Shaded circles indicate volume areas. Plunger area (A) plus annular area (B) result in increased production area (C).

Axelson's new Volumax pumps will outperform any similar pump currently available for 2" tubing.

Special ⅞" liner column uses ⅞" plunger to effectively seal and create an upper telescoping annulus. Resulting production is 22% more than that obtained with a tubing pump.

Lower portion plunger area (A), plus upper portion annulus area (B), combine to provide increased volume (C).

ALL VOLUMAX PUMPS PROVIDE THESE ADVANTAGES:

1. Volumax pumps may be operated at a depth limited only by sucker rod stress.
2. Tandem pump construction provides extreme rigidity of all parts during compression portion of stroke (downstroke).
3. Maximum fluid passage — minimum drag.
4. Optimum plunger fits established through practical field experience.
5. Exceptionally good hold-down ability.
6. An insert pump, tubing need not be pulled.

Write today for the new Volumax brochure

AXELSON

There is no economical substitute for quality.

AXELSON MANUFACTURING COMPANY

Division of U. S. Industries, Inc.
6160 So. Boyle Avenue, Los Angeles 58, Calif.

Since 1898 products designed to give oil a lift

AXELSON PRODUCTS ARE DISTRIBUTED EVERYWHERE

CALIFORNIA: Axelson Sales and Service Stores in all principal California fields
Hickey Pipe and Supply Co., (sucker rods), Los Angeles, Coalinga

MID-CONTINENT AND EASTERN: Jones and Laughlin Steel Corp., Supply Division, Tulsa

ROCKY MOUNTAIN: Jones and Laughlin Steel Corp., Supply Division, Tulsa
Great Northern Tool and Supply Co., Billings

CANADA: Jones and Laughlin Steel Sales Co., Ltd., Supply Division, Calgary
Dominion Oil Fields Supply Co., Ltd., Calgary

FOREIGN: Represented in all major oil-producing areas.

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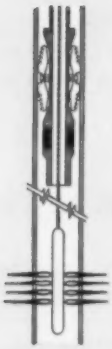
Here's what you can do with the **BAKER FULL-BORE RETRIEVABLE CEMENTER**



PERFORATE

FRACTURE
ACIDIZE
CEMENT

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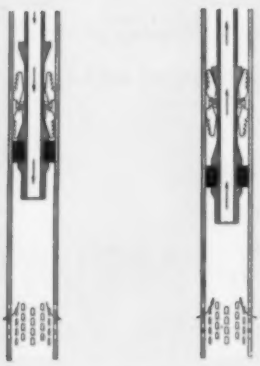

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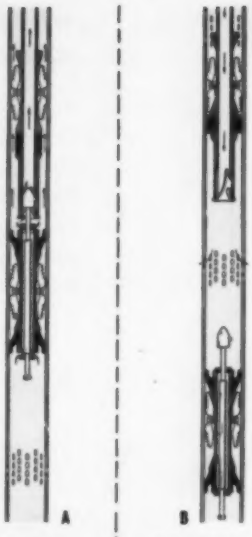

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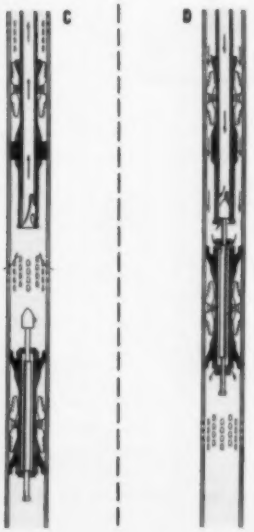

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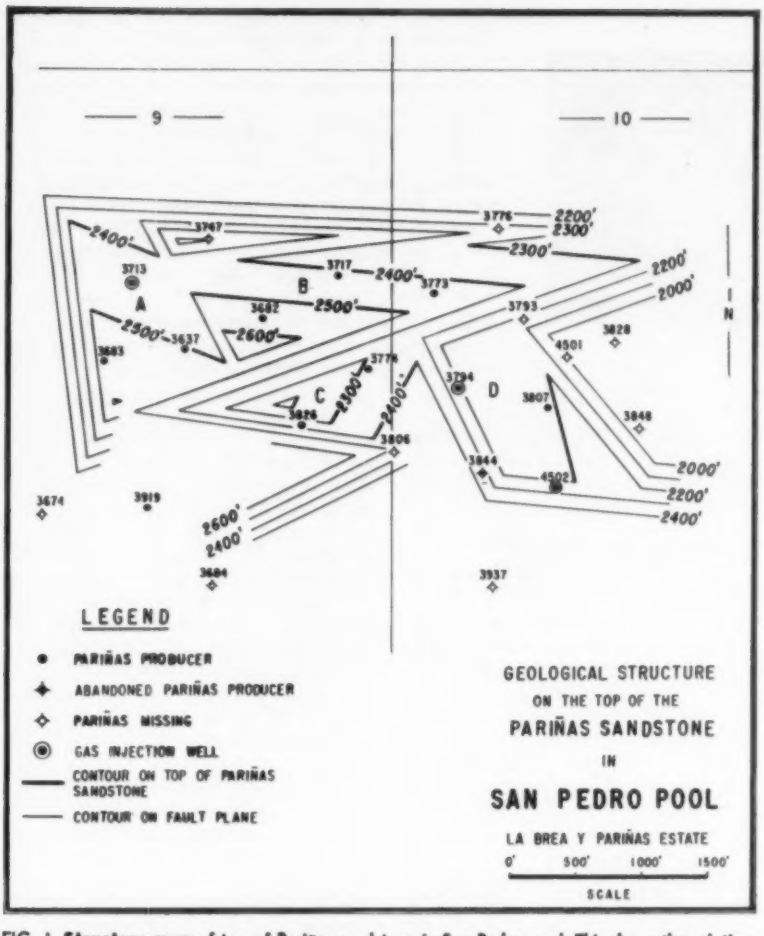

FIG. 1. **Structure map** of top of Pariñas sandstone in San Pedro pool. This shows the relationship of the four blocks in the pool, each separated by faults. Heavy lines on the map represent contours on the sand top, and the fine lines show contours on the fault planes. Only the faults separating Block D from the rest of the field had sufficient displacement to form an effective barrier to communication.

Secondary Recovery by

Butane Injection in San Pedro Block D

Butane followed by gas reaps prompt secondary payout in well-defined reservoir, northwestern Peru

Robert Moscrip, III
International Petroleum Company, Ltd.
Talara, Peru

SECONDARY RECOVERY involving butane injection, followed by injected gas, has been in progress in the San Pedro pool, Block D, in northwestern Peru, for the past six years. A substantial increase in oil recovery has been obtained in spite of the inability to obtain a satisfactory drainage pattern. Ultimate recovery of the reservoir is expected to be 350,000 bbl of oil. To May 1957, oil production was 329,740 bbl—essentially 94 percent of the ultimate goal. This is already 105,000 bbl of oil more than was expected from primary recovery operations which would have taken until 1966.

The volume of butane extracted from natural gas in northwestern Peru has exceeded the market demand for many years. From 1941 until 1951, this excess butane was stored in a depleted reservoir. Although some additional oil was obtained as a result of butane storage, optimum recoveries from the butane injection process could not be expected in this reservoir because of unfavorable reservoir conditions.

Therefore, San Pedro Block D was selected[1] as a prospect for observing the operation of the solvent extraction process under controlled field conditions. The procedure used during the field test involved the injection of butane to form a flood bank followed by gas injection to drive the bank toward the producing well.

Because the Block D reservoir was small and isolated from adjacent productive areas, the results of butane injection could be obtained in a very short time.

The San Pedro pool was discovered in May 1946, with the completion of Well 3637 in the Pariñas sand. The results of subsequent development drilling indicated that the pool was divided into four small fault blocks. These blocks are labeled A, B, C, and D on the structure map in Fig. 1. Because this structure map differs somewhat from those normally used, it will be discussed in detail in the geological section.

Following the discovery well, three producers were completed in Block D by June 1948. However, one of these was abandoned after producing only a small amount of oil. Subsequent pressure-production behavior proved that the 20-acre Block D reservoir was isolated from the rest of the pool and that dissolved-gas drive provided the predominant source of reservoir energy. Therefore, secondary recovery operations were undertaken to increase the ultimate oil recovery from this block

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and, at the same time, to provide a controlled field test of the solvent extraction process.

The project was initiated in the Block D reservoir during October 1951 by injecting butane into crestal Well 3794. During the 2.8-year period of butane injection, the rate of oil production from Well 3807, the well nearest to the point of injection increased from 33 to 170 bbl per day; and the produced gas-oil ratio decreased from 5000 to 400 cu ft per bbl. Butane injection was followed by gas injection in August 1954, after 221,838 bbl of butane had been injected. The rate of oil production increased to more than 250 bbl per day shortly after gas injection was started. Since that time oil production declined steadily and produced gas-oil ratios increased rapidly.

To the end of May 1957, total oil production from Block D was 345,740 bbl, (which includes approximately 16,000 bbl of injected butane recovered as oil) or essentially 94 percent of the ultimate recovery to be obtained by both primary and secondary operations. Thus, recovery to date represents approximately 105,000 bbl of oil more than would have been recovered ultimately by primary operations. Cumulative gas production was 1,045,092 MMcf, and 552,201 MMcf of gas was returned to the reservoir. Substantially all of the injected butane was produced with the gas and oil.

Robert Moscrip III, *is a senior reservoir engineer with the International Petroleum Company, Ltd., in Talara, Peru, where he is currently in charge of the waterflood engineering section of the petroleum engineering department. When this article was prepared he was in charge of the recovery methods section which handles the engineering aspects of the company's wet-gas and LPG injection activities.*

After receiving a BS degree in mechanical engineering from Georgia Institute of Technology, he joined Humble Oil & Refining Company in 1949. Prior to transferring from Humble to International in 1956, he was a senior petroleum engineer specializing in reservoir engineering training and formation evaluation studies in Houston, Texas.

Geological Description

The San Pedro pool is situated on the south flank of a major uplift, just below the crest of the structure. Because of erosion in the San Pedro area, a large portion of the Pariñas formation of lower Eocene age is missing. The pool is bounded on all sides by major faults and further subdivided by faults of smaller displacement into four productive blocks[2] which are labeled A, B, C, and D on the structure map presented in Fig. 1. The locations of all wells drilled in this area to the depth of the Pariñas formation are shown on the map. The heavy lines on the map represent contours on the sand top, and the fine lines show contours on the fault planes. The straight-line contours are used to illustrate structural conditions in northern Peru, where oil pools generally consist of many small blocks formed by normal faults. The bedding planes usually have dip but are not folded.

Of the faults within the field, only the ones separating Block D from the rest of the pool have sufficient displacement to form effective barriers to communication. The Pariñas formation in Block D is about 164 ft thick, of which an estimated 50 percent is effective, or net, sand. The sand is a fairly coarse, semi-friable, poorly sorted sandstone containing numerous quartz and shale pebbles. An electric log of this formation in Well 3807 is presented in Fig. 2.

The Block D reservoir occurs at an average depth of approximately 2300 ft subsea, and the dip along bedding planes is to the east at an angle of 4 deg. Absence of both an original gas cap and bottom water in this reservoir was proved by drillstem and production testing. An isopach map based on gross oil sand thickness is presented in Fig. 3. Based on the isopach map, a surface area of 20 acres was assigned to Block D.

No cores were obtained from Block D wells; however, the Pariñas sand was cored in Well 3773. Only about 60 percent of the estimated net sand in the cored interval was recovered. Based on laboratory analysis of these cores, the average porosity and permeability of the Block D reservoir were estimated to be 16.5 percent and 155 md, respectively. The average connate water saturation was estimated to be 45 percent. This value was based on the porosity and permeability distribution found in cores from Well 3773 and capillary

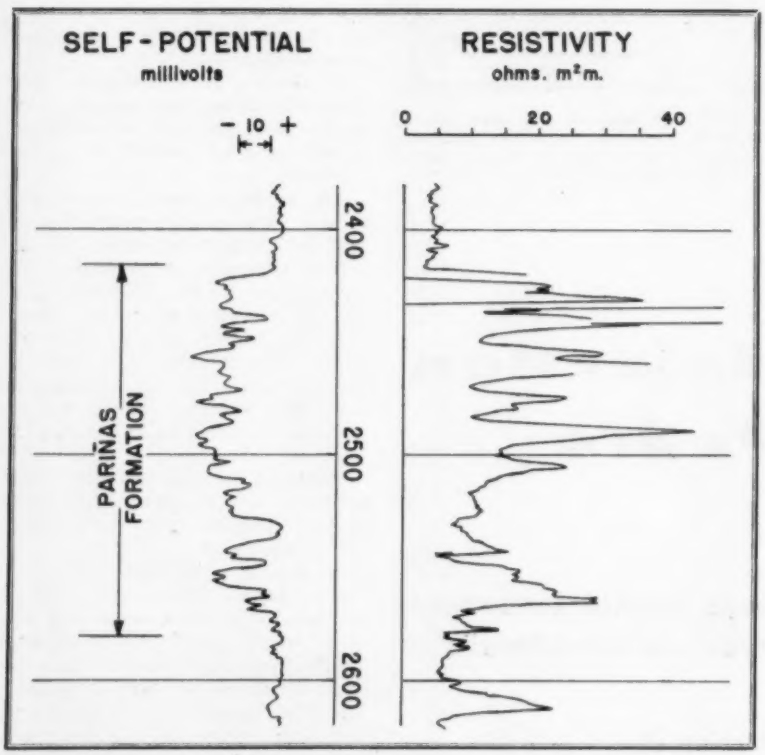

FIG. 2. **Electric log on Well 3807,** showing Pariñas sand development in Block D. This well is the nearest to the point of injection and recorded a rise in daily production from 33 to 170 bbl in 2.8 years of butane injection. This increased to 250 bbl per day shortly after gas was injected.

pressure data developed from representative Pariñas sandstone cores obtained from other wells. A summary of the average sand characteristics for Block D is presented in Table 1. The calculated hydrocarbon pore volume of Block D using these data was 1,280,000 bbl, which originally contained 1,050,000 bbl of stock tank oil. On the other hand, according to volumetric balance calculations based on pressure performance data covering the period of primary operations, there were approximately 800,000 bbl of stock tank oil in place originally.

The pore volumes calculated from the isopach map are subject to considerable error because of the complex fault system and the lack of control for locating the fault contacts and determining average gross sand thicknesses for the individual fault blocks. For example, of the three early development wells which were drilled in Block D, only Well 3807 encountered a complete section of the Pariñas formation. Also, when two additional wells were drilled in 1953 to improve the pattern efficiency of the butane injection project, one missed the sand completely, and the other encountered a faulted section where the sand development was extremely poor. However, the volume of original oil in place obtained from volumetric balance calculations is probably somewhat low because bottomhole pressures measured in the two producers reflected the reservoir conditions in the drainage area immediately surrounding these wells, rather than the average pressure throughout Block D. For this reason, Block D was assigned a volume of original oil in place equal to that obtained from geological data.

FIG. 3. **Isopach map** of gross oil sand in the San Pedro pool. The Pariñas sand is about 164 ft thick in Block D, of which about 50 percent is effective.

Reservoir Fluid Characteristics

An initial pressure of 1440 psig was measured at the pressure datum of 2300 ft subsea in Well 3794, Block D. This pressure was approximately equal to the initial pressure measured in the San Pedro discovery well, even though Well 3794 was completed 18 months after the pool discovery. The reservoir temperature at the pressure datum was 126 F.

Based on reservoir fluid samples obtained at initial completion in Wells 3637, 3717, and 3807, the reservoir oil was initially saturated with gas at original reservoir conditions. The original dissolved gas-oil ratio was 410 cu ft per bbl of stock tank oil. Average reservoir fluid properties based on the analyses of these samples are also presented in Table 1.

TABLE 1. Summary of Reservoir Data Block D, San Pedro Pool.

Sand Characteristics	
Productive formation	Pariñas Sandstone
Average depth, ft subsea	2,300
Average dip, degrees	4
Surface area, acres	20
Gross formation thickness, ft	164
Average net sand thickness, ft	82
Average porosity, percent	16.5
Average permeability, md.	155
Average connate water, percent	45
Original gas-oil contact, ft subsea	None
Original oil-water contact, ft subsea	None
Original oil in place, reservoir bbl	1,280,000
Original oil in place, stock tank bbl	1,050,000
Fluid Characteristics	
Initial reservoir pressure at datum, psig	1,440
Reservoir temperature at datum, F	126
Depth of datum, ft subsea	2,300
Initial formation volume factor res bbl/bbl STO	1,222
Initial solution gas-oil ratio cu ft/bbl STO	410
Initial oil gravity, deg API	38.7
Initial gas gravity, fraction (Air = 1.0)	0.8
Initial reservoir oil viscosity, cp	1.000*
Initial reservoir gas viscosity, cp	0.017*

*Estimated from correlation in the literature.[6]

Development and Primary Production History

The San Pedro pool is located on the La Brea y Pariñas Estate, a fee property, owned and operated by International Petroleum Company, Ltd., in the extreme northwestern portion of Peru, South America. The pool was discovered by the completion of Well 3637 in the Pariñas sandstone formation in May 1946. Subsequent development drilling on approximately 10-acre spacing resulted in the completion of 12 producing wells, three of which were in the Block D reservoir.[3] Block D was discovered in November 1947 when Well 3794 encountered an upthrown, partially-faulted section of Pariñas sand at a depth of approximately 2200 ft

subsea. Wells 3807 and 3844 were completed in February and June 1948, respectively.

Wells 3794 and 3807 were completed by setting and cementing casing through the Pariñas formation and then selectively gun-perforating the casing opposite the well-developed sand sections in the lower half of the formation. At completion they flowed oil at daily rates of 297 and 450 bbl, respectively, with no water. Well 3844 encountered only 40 ft of very poor quality Pariñas sand was completed through a pre-perforated liner opposite the potentially productive interval. However, the well flowed oil at the rate of only 13 bbl daily on initial completion. After producing 1839 bbl of oil, it was shut-in and finally abandoned in January 1951. Oil production from Block D reached a maximum of 321 bbl daily in April 1948 and declined to 33 bbl daily by June 1951. During this same period the produced gas-oil ratio increased from approximately 400 to almost 5000 cu ft per bbl, and the average reservoir pressure declined from 1440 to approximately 300 psig. Pressure-production data for this reservoir are presented in Fig. 4.

Additional productive section was opened in mid-1949 by selectively gun-perforating upper intervals in both wells. These workovers resulted in a temporary increase in oil production rates with a corresponding reduction in produced gas-oil ratios. A similar performance was obtained in mid-1951 when additional gun-perforating was done in preparation for the butane injection project. A subsurface pump was installed in Well 3807 in October 1951, and a similar installation would have been required in Well 3794 at approximately the same time if the secondary recovery program had not been undertaken.

Cumulative production to the beginning of secondary recovery operations amounted to 180,200 bbl of oil and 257,300 MMcf of gas. Ultimate primary oil production was estimated to be 225,000 bbl to an abandonment pressure of 50 psig. A plot of the pressure-cumulative production relationship is shown in Fig. 5. It was estimated that under primary operations the reservoir would be depleted in 1966.

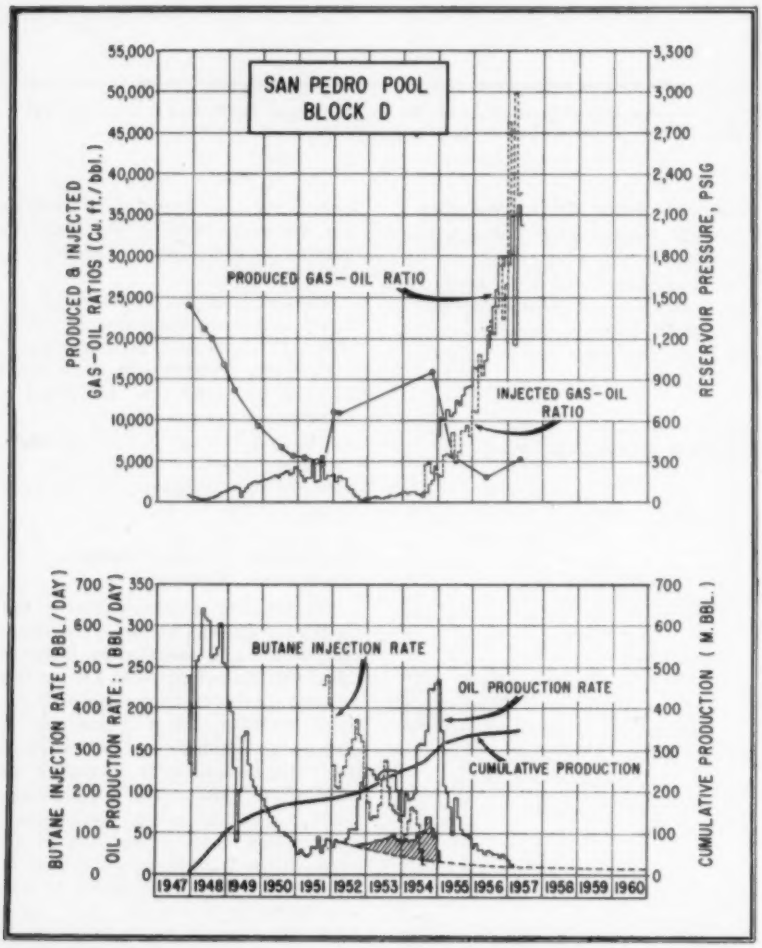
SAN PEDRO POOL
BLOCK D
PRODUCED & INJECTED GAS-OIL RATIOS (Cu. ft./bbl.)
RESERVOIR PRESSURE, PSIG
PRODUCED GAS-OIL RATIO
INJECTED GAS-OIL RATIO
BUTANE INJECTION RATE (BBL/DAY)
OIL PRODUCTION RATE (BBL/DAY)
CUMULATIVE PRODUCTION (M.BBL.)
BUTANE INJECTION RATE
OIL PRODUCTION RATE
CUMULATIVE PRODUCTION
1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960

FIG. 4. **Reservoir data graph.** Block D, San Pedro pool. Note the oil production rise following the end of butane injection in 1954 and beginning of gas injection.

Selection of Block D for Butane Injection

By consolidation and modernization of the natural gasoline processing facilities in 1940 and early 1941, the volume of butane extracted from produced natural gas was greatly increased. Inasmuch as market demand did not keep pace with the increased supply, the excess butane was stored in a depleted reservoir from 1941 until 1951. Although some secondary oil was obtained from the butane storage project, optimum recoveries from the solvent extraction process could not be expected because of unfavorable reservoir conditions. After reviewing the producing history of several reservoirs on the estate, Block D was selected[1] as the best prospect for observing the operation of the solvent extraction process under controlled field conditions. The reservoir was small, isolated from the surrounding productive areas, and in an advanced stage of depletion. Under these conditions the results of the project could be obtained in a very short time. The original recommendations for this project proposed that sufficient butane be injected initially into Well 3794 to fill approximately 15 percent of the hydrocarbon pore volume. The injected butane was to be driven toward the producing well by injecting dry gas in 3794. It was also proposed that two additional wells be completed in Block D by the time that LPG injection was terminated in Well 3794. LPG injection would then be shifted to one of the new wells in order to improve the pattern efficiency within Block D.

Reservoir Performance During Butane Injection

The secondary recovery program was initiated on October 10, 1951, by injecting butane into Well 3794 at a daily rate of 300 bbl at a wellhead pressure of 150 psig. The average composition of the injected LPG was 20 percent propane, 48 percent isobutane, 31.8 percent normal butane, and 0.2 percent iso-pentane-plus.

Within the first three months of butane injection, the reservoir pressure in the vicinity of the injection well increased from 294 to over 600 psig with the injection of 40,000 bbl of butane. During this period Well 3807 pumped about 39 bbl per day with a gas-oil ratio of 3000 cu ft per bbl. At the

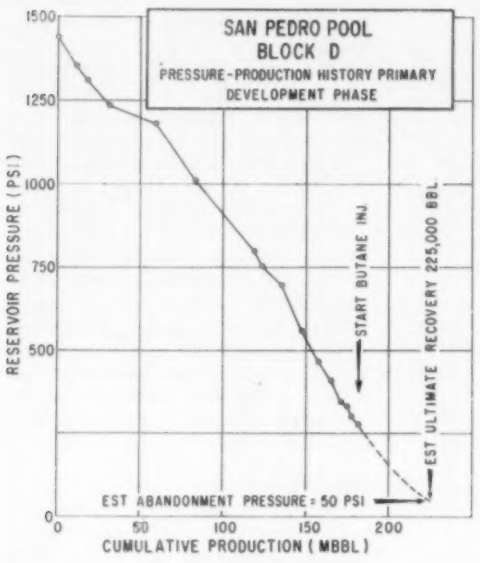

FIG. 5. **Pressure-cumulative production history** during primary operation of the Block D. Although recovery was estimated at 225,000 bbl—already more than 345,000 bbl have been produced through the butane and gas injection program.

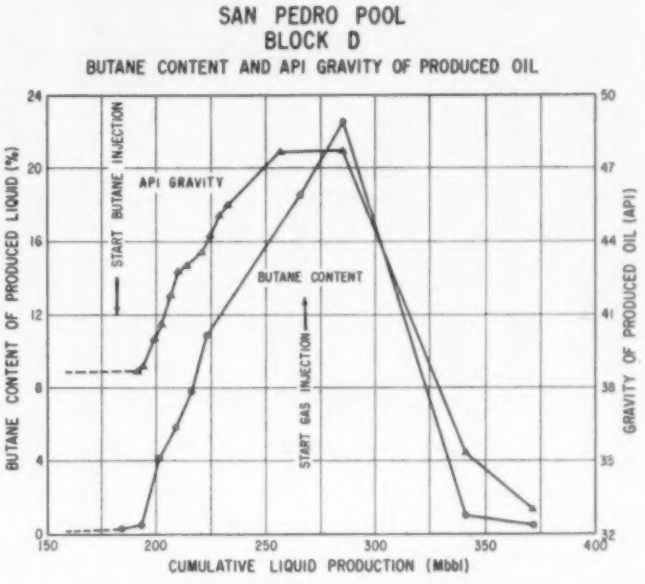

FIG. 6. **Butane content and API gravity** of produced oil during secondary operation of Block D.

end of this period, January 1952, injected butane first appeared in the gas produced from Well 3807. However, the first significant increase in oil producing rate did not occur until June 1952. These changes are presented graphically in Fig. 4. An increase in butane content of the produced oil was detected in September 1952, at which time the oil gravity also began to increase. The relationships of butane content and gravity of produced oil with cumulative liquid production are shown in Fig. 6. A similar relationship for the LPG content of the produced gas is shown in Fig. 7.

Soon after a definitely favorable response to butane injection occurred, the drilling of two new wells was recommended[4] in order to enlarge the project and to improve the pattern efficiency. However, the results of this drilling effort were disappointing. Well 4501 missed the sand, and Well 4502 encountered a tight, faulted section which had a poor productivity despite remedial measures. This well was completed as a pumping well in April 1953, with an initial daily producing rate of 5 bbl of oil with a gas-oil ratio of about 1000 cu ft per bbl.

Butane injection was discontinued in August 1954, after 221,838 bbl had been injected. The major fluctuations of injection rate reflect the variations in market demand for LPG. When butane injection was terminated, Well 3807 was producing 152 bbl of liquid per day with a gas-oil ratio of 1000 cu ft per bbl. Almost 20 percent of the produced liquid and 80 percent of the produced gas was injected butane.

Reservoir Performance During Gas Injection

Butane injection was replaced by gas injection in Well 3794 during August 1954. The initial gas injection rate was 800 MMcf per day at a wellhead injection pressure of 900 psig. Response occurred almost immediately, and within two months Well 3807 was capable of flowing at rates of over 500 bbl per day, including 22 percent injected butane. However, because the volume of butane-rich gas accompanying the high rate of oil production exceeded the capacity of existing gas-oil separation facilities, actual producing rates were curtailed. This limitation was overcome by installing two-stage gas-oil separation facilities for Block D. The high-pressure separator operated at 110 psig and the low-pressure separator at 5 in. of mercury vacuum. Previously gas-oil separation occurred in a single separator operated at vacuum.

Breakthrough of injected gas occurred in January 1955 followed by a rapid decline in rate of oil production and a sharp increase in produced gas-oil ratio. In an effort to increase pattern efficiency and reduce gas channeling, gas injection was started[5] in Well 4502 at a rate of 250 MMcf per day during March 1955, and the rate of gas injection into Well 3794 was reduced from 650 to 400 MMcf per day. This change temporarily delayed the increase in produced gas-oil ratio.

In June 1957 the remaining upper sands in Well 3807 were opened by gun-perforating. This work did not increase oil production or reduce the gas-oil ratio. Immediately following this last workover, the well produced oil at a rate of 14 bbl per day with a gas-oil ratio of 20,000 cu ft per bbl.

Cumulative recovery to the end of May 1957, has been 345,740 bbl of oil including 16,000 bbl of injected butane produced with the oil and 1,045,092 MMcf of gas including 321,000 MMcf of propane and butane, which is the gas equivalent of 233,100 bbl of LPG. Included in the volume of produced LPG are approximately 11,250 bbl which were supplied by the injected gas used to drive the butane bank and an estimated 1600 bbl which would have been produced under primary operations. The balance of the butane production (220,250 bbl) approximately equals the amount injected to form the bank. No data are available upon which to base an estimate of the amount of butane which has been

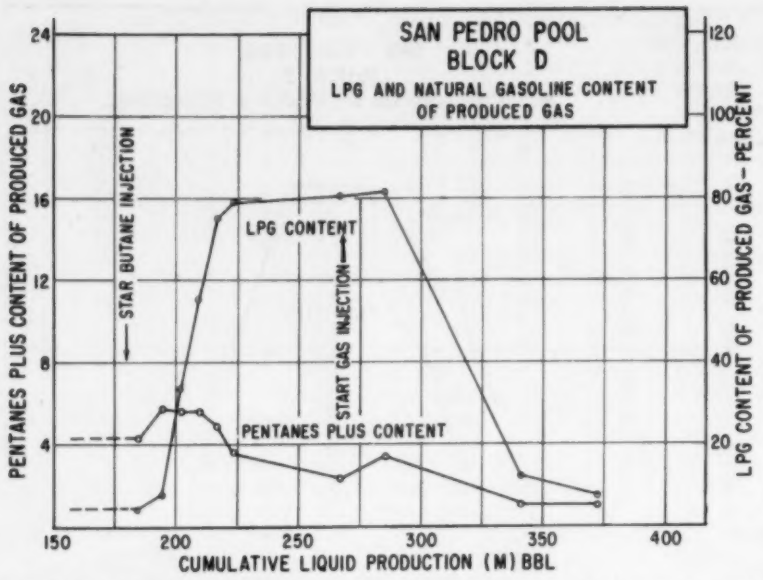

FIG. 7. **LPG and natural gasoline content** of produced gas during secondary operation of Block D. Total volume of the butane injected was 221,838 bbl.

stripped from the oil remaining in the reservoir. It is estimated that approximately 13,300 bbl of additional natural gasoline have been extracted from the produced gas during the life of this project.

To the end of May 1957, an estimated 215,940 bbl of primary oil and 113,800 bbl of secondary oil have been recovered from this project. The recoveries of primary and secondary oil together with the injected butane recovery in the oil phase are shown in Fig. 4.

Discussion of the Project

When Block D was selected for the field test of the solvent extraction process, it was believed that the reservoir hydrocarbon pore volume was 1,550,000 bbl underlying 30 surface acres. This value actually represented a compromise between the volumes determined from geological data and from pressure-production data. The potential secondary oil recovery to be obtained by using a gas-driven solvent bank was estimated to be 525,000 bbl, assuming that the residual oil saturation could be reduced to about 25 percent of the hydrocarbon pore volume. The value of residual oil saturation was based on the results of linear flooding experiments modified slightly to compensate for permeability stratification within the reservoir.

The inefficiency of the original two-well pattern was recognized when the project was in the planning stage, and recommendations covering the selection of Block D for butane injection included provisions for drilling two additional wells to insure a more complete coverage of the reservoir.

However, except for providing a basis for reducing the estimated size of the reservoir, the additional drilling was of little benefit to the project. To the south of Wells 3794 and 3807 the sand becomes less permeable as evidenced by the poor sand development in Wells 3844 and 4502 which together produced less than 4000 bbl of oil.

The total volume of butane injected was 221,838 bbl, which was considerably more than recommended initially. This was due partly to uncertainty concerning the area affected by the project and partly to delay in preparing another pool to receive butane. Although it is still impossible to determine accurately the reservoir volume affected by butane injection, the pressure production behavior during the butane injection cycle indicates that the volume affected by the solvent extraction process represents only a small fraction of the total reservoir volume of Block D. Similarly, the fact that almost all of the injected butane has been recovered in the produced oil and gas indicates that essentially all of the reservoir which was invaded by injected butane was later swept by gas.

The ultimate recovery from Block D is expected to be 350,000 bbl of oil, an increase of 125,000 bbl, or 55 percent over estimated primary recovery. Moreover, the operating life of the reservoir will be shortened by several years, and most of the oil production will be obtained under flowing conditions. Residual oil saturations cannot be calculated because the portion of the reservoir which was affected by butane injection is not known with any certainty.

The amount of butane recovered in the produced fluids was calculated on the basis of hydrocarbon analyses of the produced gas and oil. This volume was then reduced to compensate for the amount of butane recovery expected under primary operations and for the butane content of the injected gas as it was produced. Although recent hydrocarbon analyses and gravity measurements of the produced oil indicate that the butane content of the reservoir oil is now less than it was before butane injection was started, insufficient data are available for calculation of the produced volume which should be attributed to this stripping action.

Conclusions

In spite of the inability to obtain a satisfactory drainage pattern for the butane injection project in San Pedro Block D, a substantial increase in oil recovery has been obtained from this field of the solvent extraction process. The experience gained during the Block D experiment will aid in the planning of additional field applications of this process.

Substantially all of the injected butane can be recovered with the produced fluids. The amount of butane injected during this field test was considerably more than that required for efficient operation of the solvent extraction process. Additional laboratory and field tests are needed to determine the optimum LPG injection requirements.

A quantitative analysis of the effects of permeability stratification and pattern efficiency cannot be made using the data obtained during this field test.

Acknowledgment

The author wishes to thank the management of International Petroleum Company, Ltd., for permission to present this paper. Much of the information presented in this paper was obtained from reports written by J. F. Barbieri, W. E. Harris, and W. H. Holmes.

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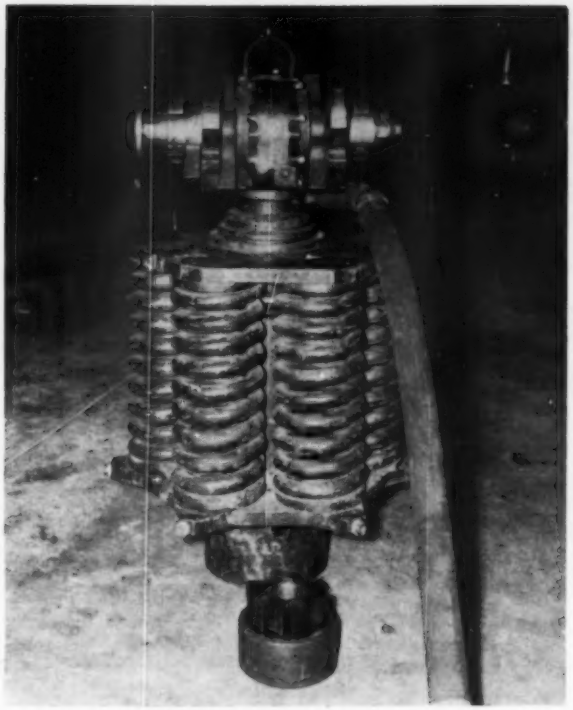


FIG. 1. **Wave generator,** or the oscillator assembly, sits above the spring platform. The hose is the flow line. Either an engine or an electric motor may act as the prime mover to drive the generator in its function as a tubing oscillator.

FIG. 2. **Side view** of the wellhead assembly of the sonic pump showing the two eccentric weights on the generator. The weights rotate in opposite directions, in phase, so as to cancel their horizontal thrust, but joining cooperatively in vertical thrusts. The spring platform permits the tubing to have free vertical movement.

Four years of testing and...

SONIC PUMP BOWS IN

Extensive field tests indicate worth of this new pump. It has handled 10 deg crude, and crude with 40 percent sand for long periods of time

THE PETROLEUM ENGINEER of March 1955, carried the industry's first comprehensive technical article on the sonic oil well pump. Today — three years, four months later, the article is valid as ever, despite the fact that the pump has undergone exhaustive tests under the toughest oilfield conditions imaginable. Except for a few changes in the design of the check valves and other very slight modifications, the pump is the same as that described originally in this magazine.

Johnston Testers, Inc., manufacturer of the pump, reports that the pump has successfully lifted crude in the 10 deg API gravity range for long periods of time without repairs; and in several instances, it has handled crude with a sand content ranging all the way up to 80 percent!

The only changes from the design of three years ago have been in the type of tubing joints (special threads are preferred to avoid the notch effect) and in the check valve which is now plastic and springless.

The engineers who supervised the shakedown of the pump say it develops an efficiency of 60 to 70 percent depending on the gravity of the crude it handles. This efficiency is based on the brake horsepower supplied by the prime mover.

Description of the Sonic Oil Well Pump

Inside the well is a string of tubing, held rigidly in the center of the casing by plastic-coated tubing guides, with plastic check valves spotted at every tool joint. The tubing is supported at the surface by a spring-loaded platform that sits atop the casing; an oscillator with eccentric rotating weights produces the vibrations that bring the oil to the surface. Power is supplied by any type of prime mover mounted on a separate base and coupled to the wave generator through a shaft with two universal joints.

In order to impose vibrations on the

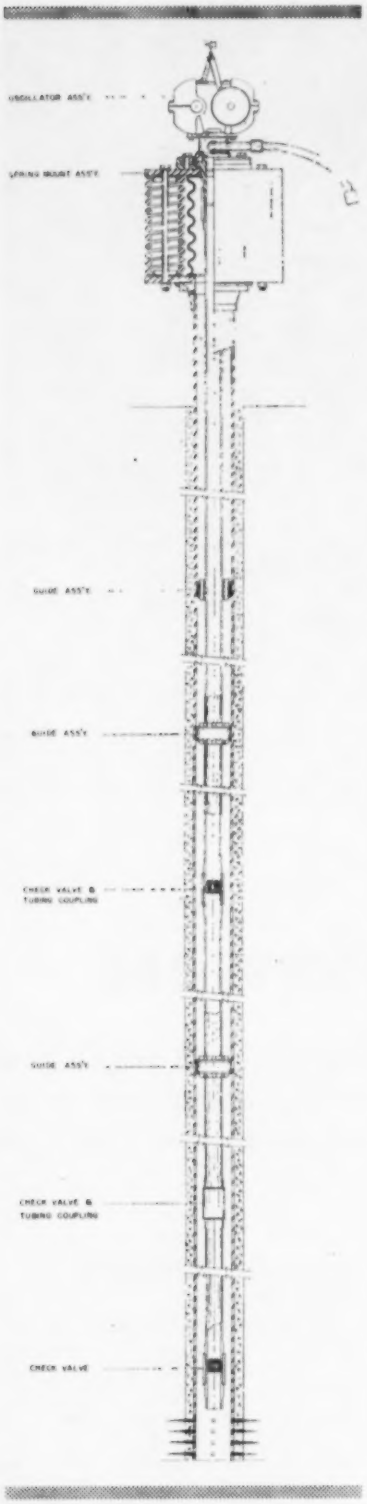


FIG. 3. **Schematic** of the sonic pump and tubing string assembly. Plastic-coated tubing guides act as centralizers and as vibration dampeners for unwanted lateral movement. Plastic check valves are spotted at every tool joint. Developers say the pump can lose as many as half of the valves and still operate efficiently.

tubing string, the oscillator must be rotated at a rate which corresponds to one of the resonant frequencies of the tubing, which depend upon the length of tubing string and the speed of sound in the tubing (approximately 16,500 ft per sec). Because the speed of sound in tubing is a constant, the resonant frequency varies with the length of the tubing string and in inverse proportions. Normally the pump operates between 600 and 1200 strokes (or cycles) per min.

The stroke of the pump is usually from 3/10 to ½-in., but can be increased to ¾-in. or more depending on the tubing used. The fluid is impelled upward by the valves on the up stroke of the pump with an acceleration of from 5 to 10 times the acceleration of gravity, depending on the frequency and amplitude of the stroke. Therefore, the fluid from the previous stroke will still be rising while the pump is completing the cycle for the next upward stroke.

The tubing string as a whole does not move up and down, but sections of the tubing, including the top and bottom sections, move according to the principle of harmonic motion in an elastic body. At the fundamental frequency the two ends of the tubing move in opposite directions through the cycle while the middle of the tubing remains relatively motionless since it is a nodal region. As the frequency is increased by whole number multiples of the fundamental frequency (2,3,4,5, etc.) the number of sections of the tubing which are in motion are increased by the whole number multiple plus one, so that at a frequency four times faster than the fundamental frequency, there will be five sections of the tubing moving, with each section moving in the opposite direction from the adjacent section. By this means the fluid is raised from valve to valve through the tubing to the surface.

The check valves which convert the vibrational energy of the tubing into pumping action open on the down stroke to pick up fluid from the bottom of the hole or permit fluid impelled upward by the valves below to pass through. On the up stroke the valves close and the fluid is impelled upward. The valves are normally concentrated in the regions where the tubing has maximum motion (antinodal regions).

Since the pump is activated by the transmission of longitudinal vibrations through the tubing, lateral vibrations which have a tendency to develop in long, thin rods such as a tubing string, must be eliminated. Therefore, guides are installed on the tubing about 10 ft apart so that any laterals that develop will be dampened out. The guides also prevent the tubing from wearing against the casing. The guides consist of a ring made of wear-resistant material with a low coefficient of friction held in place by an oil-resistant rubber spider. The guides are lubricated by returning a small amount of produced fluid down the annulus.

Although the principle of the pump may sound complicated, the actual operation of the pump is very simple. A minimum of maintenance is required since the only moving parts on the surface are the spring mount, the oscillator, the power source and the rubber hose connection between the tubing and the flow line. The oscillator has a one-quart oil reservoir which lubricates the gears and the bearings by splash feeding and should be checked twice a year by removing a level indicating plug. Non-detergent motor oil is normally used.

The spring mount on the sonic pump uses the production casing for a foundation and the prime mover requires a sinple and inexpensive base. A jack shaft, if one is required, might require a base which would also serve for a base for the prime mover. There is no counter-balancing on the sonic pump and the stroke is changed by changing the unbalance of the oscillator or the speed of the prime mover.

Surprisingly, the sonic pump can lose as many as 50 percent of the valves and still pump effectively and can pump sand, gyp and mud — providing there is sufficient fluid to move these materials up the tubing. On low volume wells, this can be accomplished by returning a large proportion of the produced fluids down the annulus.

At the present time there are three

TABLE 1. Average Pumping Efficiency — 60 to 70 Percent

Volumes: Tubing Size, in.	Stroke Amplitude, in.	RPM	Bbl per Day
2	½	800	185 - 350
2½	½	800	350 - 500
3	½	800	500 - 600
3½	½	800	500 - 700
4	½	800	700 - 1000

The above figures will vary some depending on the gravity of crude oil being pumped. The ability of the pump to handle sand is not dependent on the gravity of the crude, but only on having fluid enough to carry the sand. Many times, large quantities of fluid (oil or water) must be returned down the annulus to carry the high percentages of sand found in certain areas.

disadvantages to the sonic pump which are more than offset by the advantages it offers. First, there is a possibility of parting tubing, although this is not likely if the pump is operated correctly. Second, the tubing will be "wet" when it is pulled, unless the tubing is allowed to stand inactive for a short time. (However, with good valves and tubing, there would be no necessity for pulling the tubing.) Third, there is at present no way of determining the fluid level maintained by the pump such as the fluid pound used by pumpers with a sucker rod pump, but the unbalance on the oscillator can be increased every few days until there is no increase in production obtained with the increased unbalance.

Case Histories

1. **Problem Well No. 19.** This California well produced 10 to 12 deg API crude from an unconsolidated sand formation and the bottom of the casing had corroded off just above the cement plug. Because of this open hole condition at the bottom, the well produced large quantities of free sand, and after production was started with the sonic pump, sand content of the crude varied from 10 to 40 percent averaging between 15 and 20 percent. After shutdowns, no difficulty was experienced in restarting the pump despite the deposit of sand on the valves. Production totaled 25 bbl per day.

2. **Ventura Avenue Field Well.** The sonic pump produced low gravity crude despite the fact that at times water would cause extreme heavy sand flow. Sand content at times was estimated to be as high as 80 percent. Production: 25 to 100 bbl per day.

3. **Huntington Beach Field Well.** Crude from this well had a sand content of 60 percent. However, this percentage was cutback by producing a total of 200 bbl per day and diverting 100 bbl of de-sanded crude back in the hole — giving a net production of 100 bbl per day. In experimental runs the down-flow liquid was discontinued and the pump was allowed to produce the crude as it came from the formation. Under these conditions, the pump would function satisfactorily as long as it was not shut down. The production coming from the flow line was a thick sandy paste — with the consistency of tooth paste. After a three months run (diverting half the crude down the annulus) the pumping was discontinued because of the expense involved in disposing of the sand.

Conclusion

The sonic pump has been tested in California and Oklahoma. So far it has amply met the developer's expectations. At present time, a test of a heavy paraffin producer is being set up on the Gulf Coast. ★ ★ ★

Danheim To Direct AOSC Activity

Servicing contractors make Dallas headquarters in centralization move

James E. Danheim has been named executive-secretary of the Association of Oilwell Servicing Contractors. He has assumed direction of the fast-growing organization in its new Dallas, Texas, headquarters. Original offices of the AOSC were in Odessa, Texas.

Danheim, an attorney, was formerly associated in law practice in Austin, Texas. He received his LLB degree from the University of Texas in 1951 and is a member of the Travis County Bar Association, Central Civitan Club and Lions International.

Decision to make Dallas the new home office was made on request of AOSC members for a more central location. The contractors now claim more than 250 members with 15 chapters in seven southwestern states. Announcement of the move, and of the election of Danheim came from J. F. McAdams, president of the association. McAdams is a servicing contractor in Hobbs, New Mexico.

AOSC offices are located in the Davis Building, 1309 Main Street.

The organization has chapters in Texas, New Mexico, Louisiana, Mississippi, Arkansas, Oklahoma, and Kansas. The 250-plus memberships began with only seven members two years ago, and held its first convention in Fort Worth, January 1956, with less than 100 members attending. Its second annual convention was held in Dallas with more than 250 registrants present.

The organization's third convention will again be held in Dallas in January 1959, at the Baker Hotel.

"The AOSC has as its basic objective a vigorous competition in a healthy oilwell servicing industry. Its working plan is to pool the individual servicing contractors' thinking on such industry-wide problems as employee relations, supervisor training, safety, insurance, taxation, and public relations. Our approach to these communal problems is joint employment of specialized consultants, organized presentation of their industry's case to governmental bodies, and to the businesses with which they deal, and brainstorming among themselves at periodic meetings," says McAdams.

James A. Gobel, Jr., of Odessa has been named assistant executive-secretary and field representative for the association. Gobel has had five years experience in the oil supply industry and production equipment in the Permian Basin. For the past year he has managed the W. C. Brown Pipe and Supply Company of Crane, Texas. He is a 1949 BBA graduate of Southern Methodist University.

Officers in addition to McAdams, include J. C. Williams, Jr., first vice president, Springhill, Louisiana; Thomas E. Goebel, second vice president, Houston, and Jimmy W. Wilkins, treasurer, Odessa.

Directors include: Eastern New Mexico area: Harry Eaves, Hobbs, and Jimmie Hollis, Lovington; Central Permian Basin area: Chuck Phillips, Midland, Texas; Charles J. George, Odessa, Texas; J. R. Todd, Odessa, and Barney Foster, Odessa; North Texas area: A. Leander McAlister, Wichita Falls; West Central Texas area: Frank Bridwell, Abilene, and D. L. McDonald, Abilene; Texas Gulf Coast area: Paul Giroski, Houston, E. O. Stewart, Houston, and Sam E. Wood, Alvin; East Texas area: E. A. Major, Selman City, and C. R. Bivin, Overton; South Central Texas area: T. J. Billings, Corpus Christi, and Thomas W. Crews, Alice; Mississippi area: C. F. Martin, Laurel; North Louisiana area: A. K. Busada, Shreveport, and J. B. Markham, Shreveport; Arkansas area: T. L. Scott, Smackover, and Marshall W. Craig, El Dorado; Four Corners area: N. C. Hill, Cedar Hill, New Mexico; Southern Oklahoma area: Pauls Valley Chapter: Ralph W. Shebaster, Pauls Valley; Central Oklahoma area, Seminole Chapter: Ray Young, Seminole; Southern Oklahoma area, Ada Chapter: J. C. Shortes, Ada; North Oklahoma area: Charles A. O'Neil, Perry.

James E. Danheim

Data from five Louisiana reservoirs makes . . .

A Case for 640-Acre Spacing of Gas Wells

Paul R. Waddle,
Petroleum Engineer
Brookings, Moffatt & Waddle
Shreveport, Louisiana

WELL SPACING has been a source of disagreement since the early days of the petroleum industry. Early concepts and impressions were that recovery depended directly on well density. Latest theoretical and experimental studies, however, indicate that the mechanics of well drainage and ultimate recovery of oil and gas are independent of well spacing, and that there is no theoretically fixed finite limit of drainage to a well except as imposed by the physical boundaries of the producing formation, time being the major factor determining the distance to which a well may extend its drainage influence.

In theory, the gradual extension of a well's drainage influence or radius with time continues until the pressure becomes uniformly low throughout the sand body and approaches zero if the process is continued for infinite time, assuming that there is no influx of extraneous fluid to sustain pressure.

Results of calculations by Bruce, Peaceman, Rachford and Rice[1] with respect to drainage in a gas reservoir indicate that for a given rate of flow the pressure could be predicted precisely at any particular point in the flow path at any given time, and that the depletion of a gas reservoir resulted in a drop in pressure at the extermity of the reservoir. Their analysis demonstrates that gas can be drained from a very large area in a continuous sand body in a predictable time length.

While supported by theoretical studies, drainage by wide spacing is best verified by actual field evidence. Within a number of individual gas fields, performance histories have provided a considerable body of data to establish the fact that in a continuous reservoir formation drainage does occur over extensive areas. The following discussion presents evidence of drainage and depletion under a variety of conditions in gas fields developed on 640-acre well spacing. The fields are producing under a pressure depletion type drive and pressure behavior is the criterion of drainage and depletion, or recovery efficiency.

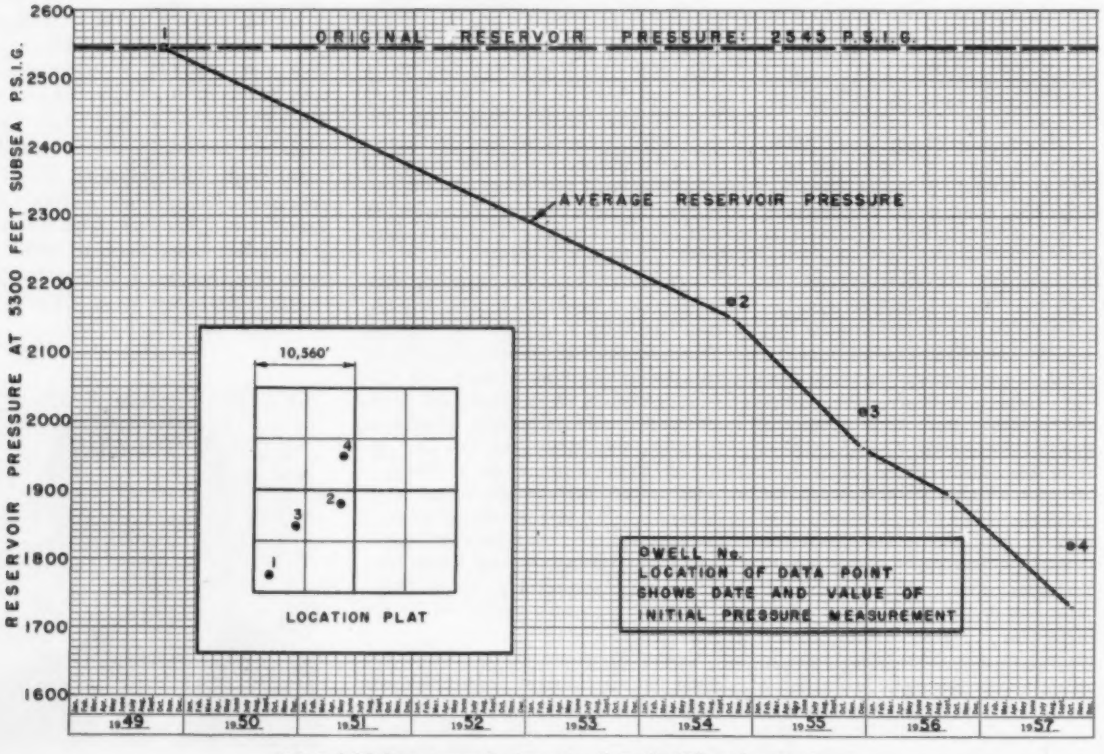
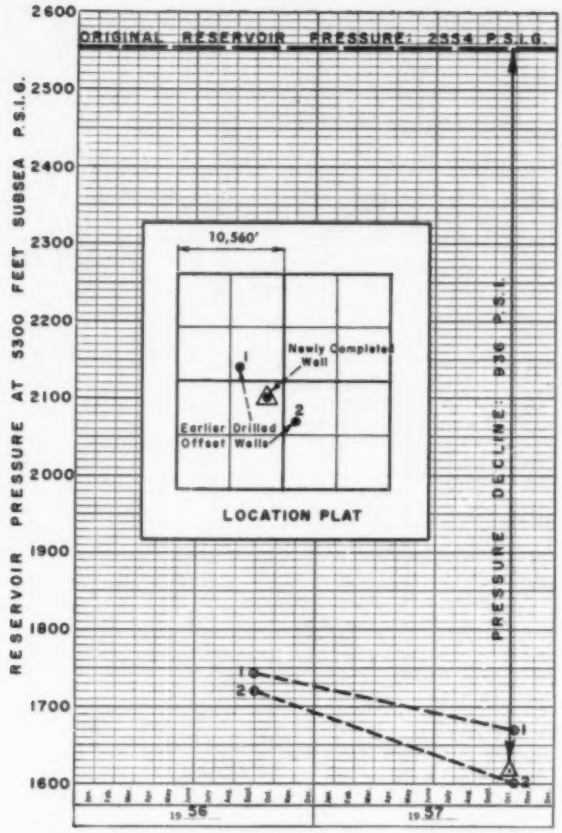
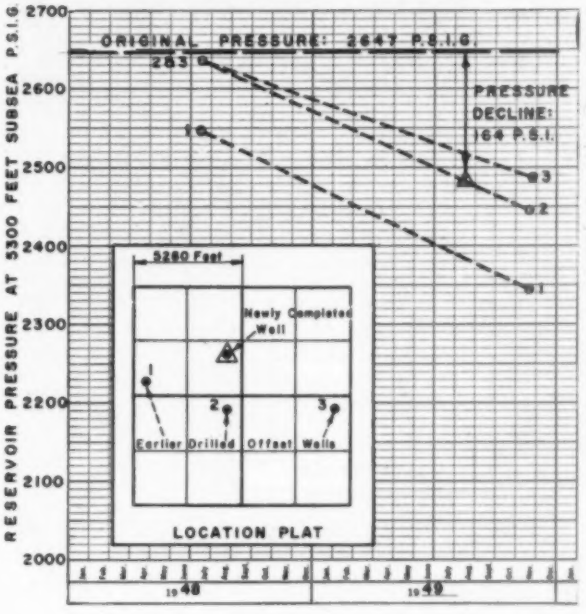


FIG. 1. **Initial pressures** in step-out wells in the Hill sand reservoir, Ada field, Bienville Parish, Louisiana. Plat indicates well locations.



◆ FIG. 2. **Comparison** between initial pressure in newly completed well (indicated by triangle) and pressures in earlier drilled offset wells. These are in the Cook sand reservoir, Ada field, Webster Parish. Location plat indicates relative positions.



◆ FIG. 3. **A newly completed well's** initial pressure is compared with that of earlier drilled offset wells. This group, as platted, are located in the Davis sand reservoir, Ada field, Webster Parish, Louisiana.

Hill Sand Gas Reservoir, Ada Field, Louisiana

An excellent illustration of drainage over extremely wide areas is found in the Hill Sand Gas Reservoir, Ada field, Bienville Parish, Louisiana. In this reservoir, the average formation thickness is 8 ft, and the permeability is 450 millidarcys. The original reservoir pressure at 5300 ft subsea was 2545 psig. The first well in this reservoir was completed in September 1949.

The second well, located 12,400 ft from the first well, was completed in September 1954 with a measured initial pressure of 2175 psig, 370 psi less than the original reservoir pressure and essentially identical to the initial well's pressure of 2120 psig on that date. It is thus indicated that withdrawals of gas from the initial well resulted in pressure draw-down over an area of more than 1600 acres.

The third well, located about midway between the first two wells, was completed in December 1955, with an initial pressure of 2015 psig which was in close agreement with field average present at that time.

Similarly the fourth and latest well, a step-out 4000 ft from well No. 2, was completed in October 1957 with an initial pressure of 1820 psig, which was close to the field average pressure.

The pressure history of this four-well gas field is shown in Fig. 1. From this evidence it may be concluded that the initial well would have served, within a reasonable period of time, to drain the entire reservoir which by geologic isopach mapping and volumetric balance calculations is indicated to be 18,400 acre-ft in size and 2300 acres in areal extent. Thus, it is clearly demonstrated that drainage has occurred over areas considerably greater than the 640-acre development pattern and that 640-acre well spacing is more than adequate to deplete the reservoir.

Cook Sand Gas Reservoir, Ada Field, Louisiana

Evidence of complete drainage in a tight sand over distances exceeding the confines of a 640-acre well spacing exists in Cook Sand Gas Reservoir in the Ada field, Bienville and Webster parishes, Louisiana. This sand has a permeability of 17 millidarcys and an average pay thickness of 15 ft. As shown in Fig. 2, the original reservoir pressure was 2554 psig at 5300 ft subsea. Initial production was in 1947. Development was on 640-acre spacing.

The latest well, completed in October 1957, as a location offsetting two producing wells, had an initial pressure of 1618 psig, 936 psi below the reservoir initial pressure and very close to the pressures of the two offset wells at that time. This pressure history points to existence of complete drainage by earlier drilled wells from portions of the reservoir beyond the limits of 640-acre development in a formation of low permeability.

Davis Sand Gas Reservoir, Ada Field, Louisiana

Another example of drainage by 640-acre well spacing is the Davis Sand Gas Reservoir in the Ada field, Louisiana. This sand has a permeability of 32 millidarcys and an average thickness of 16 ft. Fig. 3 shows the comparison between initial pressure in a late well and pressures in earlier drilled offset wells. Initial pressure measure in the delayed well was 2483 psig, a decline of 164 psi below the original reservoir pressure and in close agreement with the offset wells on that date. Again the adequacy of 640-acre spacing to drain a comparatively tight formation is substantiated.

McFearin Sand Gas Reservoir, Dubach Field, Louisiana

Communication between two 640-acre spaced wells in a thin, tight formation is evidenced in the McFearin sand gas reservoir in the Dubach field, Lin-

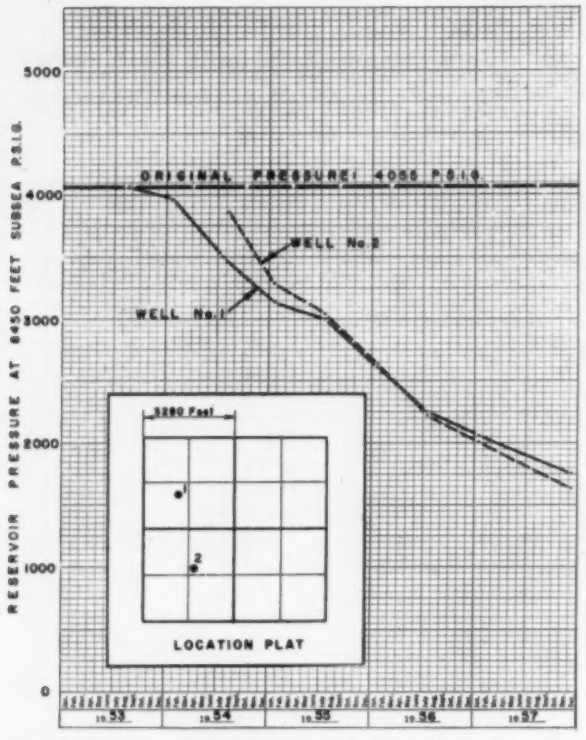


FIG. 4. **Reservoir pressure history** of the McFearin sand, Dubach field, Lincoln Parish, Louisiana.

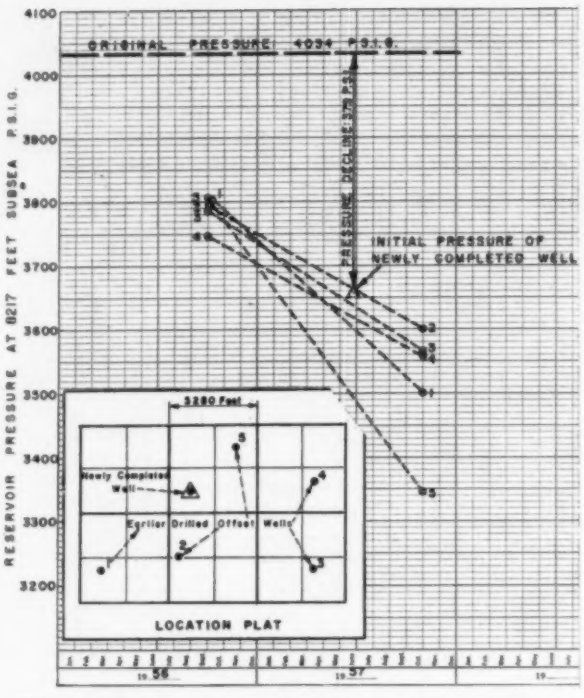


FIG. 5. **Comparison** between initial pressure in newly completed well and pressures in earlier drilled offset wells in the Cotton Valley "D" sand, Greenwood-Waskom field, Caddo Parish, Louisiana.

coln Parish, Louisiana. The sand has a permeability averaging 15 millidarcys and an average effective sand thickness of 6 ft. The reservoir was discovered in August 1953 and had an original pressure of 4055 psig at 8450 ft subsea. The second well was completed in August 1954 with an initial pressure of 3853 psig which was 202 psi below the original reservoir pressure and 403 psi above the pressure in the discovery well at the time.

The accumulation of additional production resulted in pressure equalization between the two wells by January 1955, and close agreement in the wells' bottom hole pressure has continued to the present date, as shown in Fig. 4. Volumetric balance calculations indicate that the two wells are draining a reservoir volume of 7950 acre-ft, or an area of 1325 acres. This history of pressure reaction provides concrete evidence of the ability of 640-acre well spacing to effect complete drainage and uniform depletion of this gas reservoir, although it is of low permeability.

Cotton Valley "D" Sand Gas Reservoir, Greenwood-Waskom Field, Louisiana

Another case of marked pressure reduction in an area of delayed development due to prior production from earlier drilled portions of the reservoir is found in the Cotton Valley "D" Sand in the Greenwood-Waskom field, Caddo Parish, Louisiana. The formation has an average permeability of 52 millidarcys and an average thickness of 20 ft. In Fig. 5 are shown the bottom hole pressure measured in a well drilled in mid-1957 as an interspaced edge location offset by five producing wells, and the pressures of the offset wells. The initial pressure in this well was 3655 psig, close to the pressures of its five offset wells and representing a decline of 379 psi from the initial field reservoir pressure. The 640-acre well spacing on which the field is developed is thus indicated to be adequate to deplete this gas reservoir.

Choice of Well Spacing Programs

If it is acknowledged that drainage can occur over great distances, and that well spacing does not physically affect the ultimate recovery from a gas reservoir, then the choice of a specific well-spacing program for a given field depends on the number of wells that are required (1) to provide adequate geologic information regarding structural trend and continuity of the reservoir, and characteristics of the reservoir rock, and (2) to deplete the reservoir within reasonable time limits.

In a reservoir consisting of a uniform blanket sand over large areas where evidence of structural irregularities are lacking, a low well density may give the necessary geologic information

THE AUTHOR

Paul R. Waddle, *a petroleum engineer, is a partner in the consulting firm of Brookings, Moffatt and Waddle, Shreveport, Louisiana. He received his BS degree in petroleum engineering from the University of Oklahoma in 1943. He worked for The Carter Oil Company from 1945 to 1957 in Kansas, Oklahoma, Arkansas, Louisiana, Mississippi and Alabama, attaining the position of division reservoir engineer in the company's southern division at Shreveport. He received special reservoir training at Carter's research laboratory and assisted in teaching reservoir engineering at special reservoir engineering schools conducted annually by the research and production departments of the company. He resigned from Carter in February 1957 to enter the engineering consulting practice and recently became associated with the oil and gas consulting firm, Brookings, Moffatt and Waddle.*

TABLE 1. Texas Gas Fields With Proration Units of 640 or More Acres Per Well.

Field and reservoir	Basic unit: Acres per well
DISTRICT 1:	
Leona River—Olmos	640
Plumly—Navarro	640
DISTRICT 2:	
Karon — Slick	704
DISTRICT 3:	
Collegeport — "1-A"	704
Collegeport — "2"	704
Collegeport — "3"	704
Collegeport — "4"	704
Collegeport — "5-East"	704
Collegeport — "5- West"	704
Collegeport — "5-A"	704
Collegeport — "6"	704
Collegeport — "7"	704
Collegeport — "7-C"	704
Collegeport — "8"	704
Madisonville — Sub-Clarksville	687
Madisonville — Georgetown	698
Sargent, South — 3200 ft Miocene	640
Sargent, South — 4050 ft Miocene	640
Sargent, South — 6350 ft Miocene	640
DISTRICT 4:	
La Sal Vieja — Zone No. 3	646
La Sal Vieja — Zone No. 6	651
Monte Christo — Zone No. 27	640
Monte Christo — Zone No. 57	640
Murdock Pass — Marginulina	640
Mustang Island — 7810 ft Sand Zone 5	704
Red Fish Bay — Mustang Island — Zone 10	704
Red Fish Bay North — Zone 10	640
San Carlos — FD-93 Sand	680
San Carlos — FE-59 Sand	660
San Manuel — 8300 ft Garza	640
Starr County, Northeast — K-1 Sand	704
Stedman Island — 7300 ft Sand	704
DISTRICT 5:	
McBee — Rodessa	689
McBee — Travis Peak	689
Teague — Pettit	673
DISTRICT 6:	
Allentown — Fenley Lime	680
Blocker — Pettit	699
Blocker — Travis Peak	659
Hallsville, South — Rodessa	704
Hallsville, South — Lower Pettit	704
Hallsville, South — Page	704
Henderson, South — Pettit	649
Henderson, South — Travis Peak	649
Huxley — Pettit	704
Jacksonville — Rodessa	641
Joaquin — Jeter	703
Lansing, North — Young Lime	704
Minden — Travis Peak	703
North Scottsville — Lower Pettit	704
Trawick — Pettit	704
Waskom — Upper Hill	703
Waskom — Hill	704
Waskom — Lower Rodessa	704
Waskom — Byrd	704
Waskom — Upper Pettit	704
Waskom — Lower Pettit	704
Waskom — Travis Peak No. 1	704
Waskom — Travis Peak No. 2	654
Waskom — Travis Peak No. 4	640
Waskom — Travis Peak No. 5	698
Waskom — Cotton Valley	697
Willow Springs — Henderson	704
Willow Springs — Rodessa	704
Willow Springs — Pettit	695
Willow Springs — Middle Pettit	671
Willow Springs — Travis Peak	704
Yantis — Rodessa	697
DISTRICT 7-C:	
Sonora — Upper Canyon	640
DISTRICT 8:	
Puckett — Devonian	640
DISTRICT 10:	
Chunn	704
Feldman — Tonkawa	662
Hansford	704
Hansford, North — Douglas	640
Hansford, North — Tonkawa	640
Hansford, North — Low Pressure Morrow	640
Hansford, North — Morrow	640
Perryton, West — Morrow	644
Texas Hugoton — Dolomite	640
Texas Hugoton — Morrow	640
Texas Hugoton — Granite Wash	640
Twin Tonkawa	662

and further serve by means of pressure reaction between wells to corroborate the reservoir continuity indicated by geologic control. In severely faulted and divided areas a high density of wells may be required to meet the irregular structural dimensions and identify each reservoir segment.

The factor of depletion rate is an economic consideration involving time and investment costs. Each field presents a separate problem and requires individual study for determination of the economic questions bearing on the specific case. Well spacing influences depletion time and hence economics, in that closer spacing may permit shorter depletion time to attain any given cumulative recovery. The study of this relationship in a specific field would involve comparisons of well spacing versus return on well investment to arrive at the optimum spacing program for the existing conditions of depletion time and economic limit.

Present Trend in Well Spacing

Operators and state regulatory bodies are inclining toward wider spac-

TABLE 2. Louisiana Gas Fields With Spacing of 640 Acres Per Well.

Field and Reservoir	State Order No.
HOUMA DISTRICT:	
Amelia — Herff Sand	29-A
Laurel Ridge — 10,200 ft Sand	131
Laurel Ridge — 10,600 ft Sand	131
LAFAYETTE DISTRICT:	
North Tepetate — Klump No. 2	91
North Tepetate — 8,000 ft Sand	91-C
LAKE CHARLES DISTRICT:	
Lakeside — 10,000 ft Sand	113
MONROE DISTRICT:	
Bridge Brake — Hosston	298
Bridge Brake — Pettit	298
Bull Creek — Smackover	365
D'Arbonne — Bodcaw	179
Indian Lake — Lower Cretaceous[1]	305
West Monroe — Cotton Valley	371
NEW ORLEANS DISTRICT:	
College Point, St. James — 10,700 ft Sand	106
SHREVEPORT DISTRICT:	
Ada — Upper Batton	99-E; 99 E-1; 99-K; 99-O
Ada — Lower Batton	99-E-1; 99-F; 99-K; 99-O
Ada — Cook	99-A; 99-B; 99-K; 99-O
Ada — Davis	99; 99-A; 99-B; 99-K; 99-L; 99-O
Ada — Hill	99-G; 99-K
Ada — Hosston	99-M; 99-O; 99-P
Ada — Pettit	99-D; 99-K; 99-L; 99-O
Bear Creek — Brown	78-A; 78-12; 78-C
Bear Creek — Brown-Ozley	78-D
Bear Creek — Hosston	78; 78-11; 78-12; 78-C
Bear Creek — Pettit	78-11; 78-12; 78-C; 78-E

(TABLE 2. Continued.)

Bethany Longstreet — Hill	289-E
Bethany Longstreet — Hosston	289-A; 289A-a; 289-B
Bethany Longstreet — Johns Sand	289-E
Bethany Longstreet — Pettit	289-A; 289A-a; 289-B
Blackburn — Bodcaw	353
Bryceland — Brown-Ozley	78-D
Bryceland — Ozley	145
West Bryceland — Advance "A"	241
West Bryceland — Advance "B"	241
West Bryceland — Teasley "A"	241
West Bryceland — Teasley "B"	241
Carterville — Smackover "A"	351
Greenwood Waskom — Cotton Valley "D"	270-B
Greenwood Waskom — Hill-Rodessa	270-B-a
Greenwood Waskom — Pettit	270-B-a
Greenwood — Travis Peak	270-B-a
Hico Knowles, Dubach — Bodcaw Sand	137; 137-E-A
Hico Knowles, Dubach — McFearin Sand	137-C; 137-C-1; 137-C-3 thru 10
Hico Knowles, Dubach — Vaughn Sand	137-2; 137-E
Ivan — Davis Sand	269; 269-A; 269-A-1
Kingston — Rushing (Pettit)	376
West Lisbon — Vaughn Sand	334-B; 334-B-1
Logansport — Ashton Sand	28-G
Logansport — Jeter	28-C; 28-C-20; 28-C-20-2; 28-C-23; 25 thru 29; 28-K
Logansport — Pettit	28-E; 28-E-19 & 20; 28-K
Logansport — Walnut Paluxy	28-F; 28-F-3
Ruston — Bodcaw	164-a; 164-E
Ruston — "D"	164-a
Ruston — Hosston	164-D; 164-D-1
Ruston — Vaughn	164-a
Sentell — Bodcaw	251; 251-1; 251-B; 251-C; 251-C-1
Sentell — Roseberry	251-A
Simsboro — Fowler	222
Simsboro — Gardner	222
Simsboro — Hill	222
Simsboro — Hosston	222-1
Simsboro — Hosston "L"	222
Simsboro — James	222
West Simsboro — Hosston	327
Sligo — Cotton Valley "D"	8-B
Sligo — Hosston	8-B
Spider — Anthony	92
Spider — Pettit	92-A; 92-A-2; 92-A-14
Stonewall — Pettit	317
Terryville — Cotton Valley "D"	370
Unionville — Vaughn Sand	206-A thru A-3; 206-B; 206-C

[1]683 Acres Per Well

ing for gas wells to effect efficient recovery and conservation. Spacing of 640 acres per well has been the pattern most frequently employed in recent years, particularly in those gas reservoirs lying below depths of 5000 ft. In some of the deeper reservoirs, low per-acre recoveries caused by factors of low porosity, high connate water and thin pay zones combine with high well investment costs to make development programs of less than 640 acres per well economically unattractive.

Table 1 lists the gas fields in Texas with well proration units of 640 acres or more. Forty-one fields with 81 different reservoirs are in this tabulation.

Table 2 gives the gas fields in Louisiana with well proration units of 640 acres. There are 32 fields with 71 separate reservoirs in this tabulation. The conservation laws of Louisiana recognize the significance of well spacing in the accomplishment of the greatest ultimate recovery of hydrocarbons contained in a reservoir. The Commissioner of Conservation is empowered to establish gas well units of the maximum area that may be efficiently and economically drained by one well. The Louisiana conservation laws take note that in adopting such well units particular care must be exercised in determining the maximum area that one well can efficiently and economically drain through a proper interpretation of data available from geological, engineering and economic considerations.

Reference

[1]Bruce, G. H., D. W. Peaceman, H. H. Rachford Jr., and J. D. Rice, "Calculations of Unsteady-State Gas Flow Through Porous Media," *Trans.* AIME, (1953) 198, 79.

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TABLE 3. Data Plotted in Fig. 1 Through 5.

Well	Date	Reservoir Pressure psig
FIG. 1. HILL SAND—ADA FIELD		
Well No 1 (original res. press.)	9-49	2545
	9-54	2120
	12-55	1960
	10-57	1720
Well No. 2 (initial)	9-54	2175
	12-55	1915
	10-57	1640
Well No. 3 (initial)	12-55	2015
	10-57	1760
Well No. 4 (initial)	10-57	1820
FIG. 2. COOK SAND—ADA FIELD		
Well No. 1	10-1-56	1741
	11-1-57	1670
Well No. 2	10-1-56	1720
	11-1-57	1600
Newly Completed Well	10-20-57	1618
FIG. 3. DAVIS SAND—ADA FIELD		
Well No. 1	7-15-48	2547
	11-20-49	2345
Well No. 2	7-15-48	2633
	11-20-49	2444
Well No. 3	7-15-49	2633
	11-20-49	2485
Newly Completed Well	8-15-49	2483

Well	Date	Reservoir Pressure psig
FIG 4. MCFEARIN SAND—DUBACH FIELD		
Well No. 1 (original res. press.)	8-24-53	4055
	1-19-54	3966
	7-19-54	3501
	1-23-55	3136
	7-12-55	3001
	1-16-56	2604
	7-10-56	2250
	1-12-57	2054
	12-4-57	1752
Well No. 2 (initial)	8-13-54	3853
	1-22-55	3289
	7-12-55	3036
	1-18-56	2614
	7-10-56	2232
	1-7-57	2010
	12-4-57	1631
FIG. 5. COTTON VALLEY "D" SAND—GREENWOOD—WASKOM FIELD		
Well No. 1	10-1-56	3803
	11-1-57	3500
Well No. 2	10-1-56	3796
	11-1-57	3600
Well No. 3	10-1-56	3787
	11-1-57	3564
Well No. 4	10-1-56	3748
	11-1-57	3558
Well No. 5	10-1-56	3808
	11-1-57	3344
Newly Completed Well	5-27-57	3655

West Texas field once 'opened by mistake' now . . .

64,000-Acre Waterflood Promises Spraberry Payout

L. F. Elkins,
Manager of Production Research
Sohio Petroleum Company
Oklahoma City, Oklahoma

- ***Texas-size 9-section "pilot" flood to kick off Sohio-proposed project***
- ***Tidewater, Phillips, Magnolia indicate additional unit flood projects***
- ***Atlantic, Humble pilot tests, now complete, prove flood feasibility***

SEVEN YEARS ago hotel rooms, drilling rigs and casing were almost impossible to obtain in West Texas — the Spraberry boom was on. Optimism was high with visions of five to ten thousand wells required for 40 acre development of the prospective 200,000 to 400,000 productive areas indicated by intergrowth of the various Spraberry fields — Tex Harvey, Germania, Midkiff, Driver, Pembrook, Aldwell, Weddell and Benedum — into one single giant field.

Boom!

Many operators and promoters talked of recoveries up to 10,000 bbl per acre based on sustained productivity of early wells and presence of open fractures in many cores. More conservative operators talked in terms of 2500 to 3500 bbl per acre. During 1951 drilling activity increased from only a few scattered wells to a maximum of 235 active rotary rigs. Nearly 200 wells were completed during December 1951.

Bust!

This optimism soon waned to abject pessimism when wells in the more fully developed areas began precipitate decline in production and gas-oil ratios skyrocketed within a few months after completion. Drilling declined considerably during the last half of 1952 and reached a low of ten wells completed in November 1952.

Wags dubbed the Spraberry the

FIG. 1. **Spraberry development** now approaches 305,000 acres with 3225 wells spaced variably on 40, 80 and 160-acre density. Field designations that go together to make the Spraberry, and proposed waterflood units are shown.

Presented under the title "Spraberry Waterflood Possibilities" at the 35th annual meeting of the National Oil Scouts & Landmen's Association in Tulsa, Oklahoma, June 6, 1958.

"Largest Non-commercial Oil Field Ever Discovered" and suggested a large sign be erected in the Spraberry Trend — "Opened by Mistake."

Development has proceeded at a moderate pace ever since with each well more carefully evaluated in light of the actual reservoir conditions rather than those hoped for earlier.

Fortunately the unusual characteristics of the producing formation and uncertainties of reservoir performance were recognized early enough to encourage many of the operators to perform the extensive field tests and research necessary for proper interpretation and thus better guidance of remaining development.

Analyses and field tests have now led to probable waterflooding of the Spraberry which, through actual field pilot test, has every indication of being highly profitable — even to the extent of making up losses many operators have suffered during primary production operation.

Within the next few months thousands of royalty owners will be contacted to obtain their agreement to unitization contracts.

Reservoir Characteristics

For proper background, the nature of the reservoir itself must be studied. The Spraberry is a 1000 ft section of sands and shales of lower Permian age occurring at an average depth of about 7000 ft. The principal pay sections are an upper sand about 30 ft thick, productive over most of the field, and a lower sand about 25 ft thick, productive over part of the field. Some lesser sands just a few feet thick produce in local areas. All Spraberry sands are very tight — less than one millidarcy — and would not produce at commercial rates if the formation were not highly fractured in an extensive inter-connected vertical fracture system covering the entire field. These fractures are evident in nearly all cores recovered. Extent of these fractures is almost unbelievable as proved by reduced pressure observed in new wells at distances up to one or two miles from previously producing wells and by results of pilot water floods. The time lag of pressure and production decline in shut-in wells a quarter to one-half mile from producing wells is only a few weeks.

Spacing

Observation of these pressure and production effects at these distances in closely controlled field tests led the Texas Railroad Commission to change regulations from 40-acre spacing and to authorize development and grant allowables on the basis of 80-160 acres per well after December 1952. Most of the drilling since then has been on these wider spacings. The wisdom of it is reflected in the relative payout position of these wider spaced wells compared to more closely spaced wells drilled even earlier.

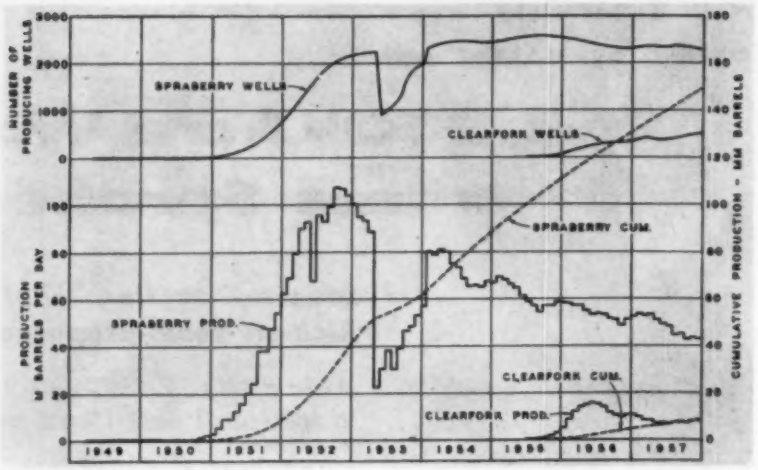


FIG. 2. **Production history** of the Spraberry Trend and Benedum field is short and somewhat erratic. Pronounced production and producing wells "dip" in 1953 is caused by shut-in period in April of that year.

The developed area now approaches some 305,000 acres with 3225 wells spaced variably on 40, 80 and 160-acre density leaving many internal locations undrilled. (Fig. 1).

Production

Cumulative production of the Spraberry Trend Area has totaled 150,000,000 bbl and production rate has declined to 42,900 bbl per day in December 1957. Field performance history is summarized in Fig. 2. Decline of field-wide production of only 60 percent over five years from the 107,000 bbl per day peak in October 1952 is deceptive because the decline has been retarded by moderate but continuous development of an additional one thousand wells during this period. Individual wells and leases have declined more nearly 30 to 75 percent per year. Production now averages only 19 bbl per well per day and many wells and leases produce little or no oil. Some 185 wells have been abandoned already, mostly in the older Tex Harvey-Germania area and 260 more plugged back to the Clearfork. Perhaps many more would have been plugged if it weren't for the pending waterflood since over 500 more are off production. These very low production rates keynote the need for early action in unitizing large areas for waterflooding.

If waterflooding cannot be accomplished within the next year or so, many leases scattered throughout the area will become uneconomic and the wells plugged. Then waterflooding the Spraberry will likely become only a passing dream — gone forever — and all owners — working interest and royalty interest alike — will be the losers.

Core data and reservoir performance indicate oil in place to be of the order of 6000 bbl per acre in the Upper Spraberry and maybe half that much in the Lower Spraberry overall. Actual values are indeterminate because no methods have been developed to really identify the "net" producing pay section.

Cumulative recovery, however, averages only 500 bbl per acre which is just 6 to 8 percent of oil in place. Reservoir engineers think this unusually low percentage recovery is caused by capillary retentive forces — blotter action — accentuated by the large number of naturally occurring fractures in this low permeability sand. These fractures thus were a mixed blessing: On one hand they permitted production from a reservoir too tight to produce if the oil actually had to flow through the rock matrix to the wells; on the other, they modified capillary forces to restrict primary recovery to maybe a third of what it might have been in an unfractured sand having higher permeability.

Within less than a year after Spraberry development accelerated in 1951 many reservoir engineers recognized the important features of the Spraberry reservoir performance and probability of very low primary recovery. Conventional approaches of increasing recovery by gas injection or water injection did not appear promising to most engineers and operators because they visualized rapid channeling of injected fluids from the input wells to producing wells through the open fractures.

Atlantic Refining Company's research engineers, however, using their background of basic research on effects of capillary forces on displacement of oil from porous media by water injection, visualized a new approach to waterflooding tight fractured sands such as the Spraberry. Simple laboratory tests, such as submerging oil saturated core fragments in a tumbler

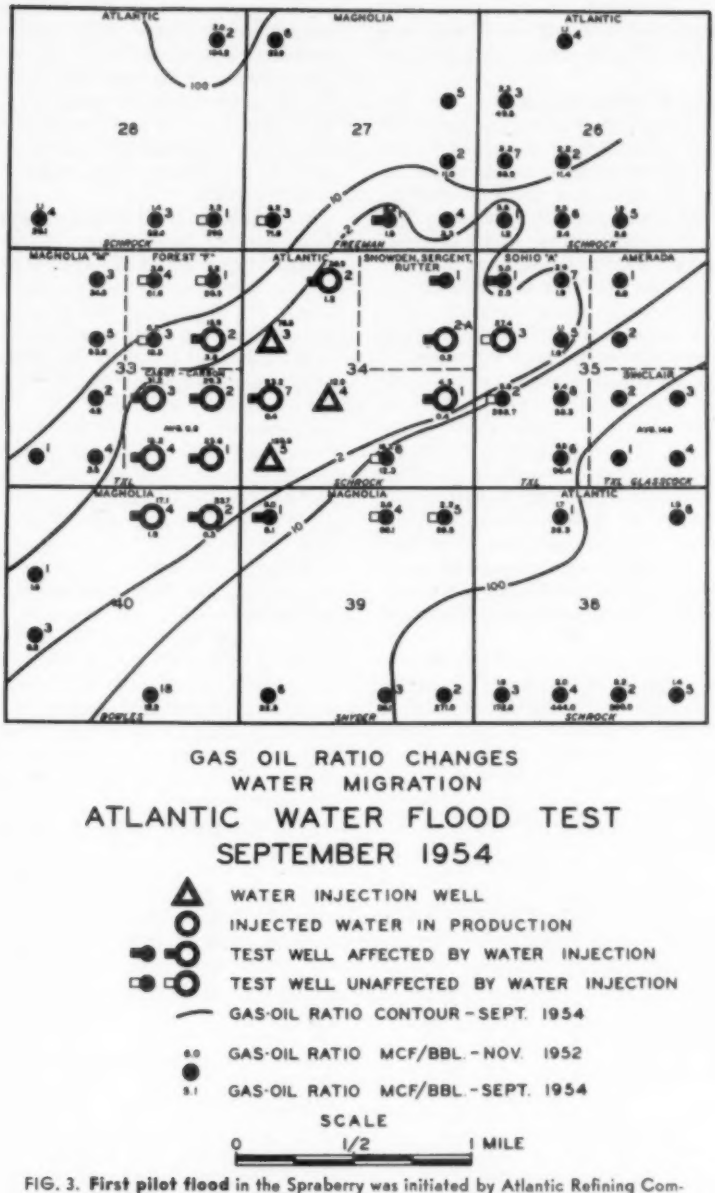


FIG. 3. **First pilot flood** in the Spraberry was initiated by Atlantic Refining Company in the Driver area. It was begun in November 1952 and water injection was stopped August 1, 1955.

of water, showed the blotter action of the sand would absorb water preferentially even to the extent of displacing a reasonable fraction of the oil out of the sand which appeared as droplets on the core surface. Their calculations led them to believe the process would work in the reservoir and Atlantic's management backed this faith with a field pilot test in the central Driver area.

Atlantic's Pilot Test

Starting in November 1952, water was injected into three wells as shown in Fig. 3 which comprised part of a normal five-spot pattern. Injection rates reached 650-700 bbl per well per day — essentially by gravity flow. A total of 1,477,000 bbl was injected by August 1, 1955 when the test was terminated.

Atlantic's injection of water arrested the decline in production of a number of wells and increased the oil production of a few. Gas-oil ratios declined significantly from the range of 4000 to 125,000 cu ft per bbl to less than 2000 cu ft per bbl in 18 wells in a northeast-southwest trend from the water injertion wells.

These low ratios contrast sharply with gas-oil ratios typically 10,000-300,000 cu ft per bbl in nearby wells northwest and southeast of this trend during the test period. Injected water appeared in modest quantities in eleven producing wells and in large volume in only one producing well during the test.

This water production conforms closely to the pattern of greatly reduced gas-oil ratios. Together they outline an approximate 1000-acre area presumed to have been significantly affected by the water injection which totaled 1,000,000 bbl by mid-September 1954 and 1.4 million bbl ultimately within the same confines—900 to 1400 bbl per acre respectively. This contrasts sharply with the 50-100 bbl per acre gas space in the formation created by oil production and shrinkage.

This volumetric comparison indicates beyond any reasonable doubt that water went into the rock matrix and the significant reductions in gas-oil ratios indicate the fractures must have become highly re-saturated with oil.

Fig. 4 outlines composite performance of 15 wells most affected by water injection and ten other test wells judged to be unaffected. Following 75 percent decline in production in the last nine months of 1952 the affected wells stabilized at 200-300 bbl oil per day total in 1953 and first half 1954. Composite gas-oil ratio declined from 10,000-20,000 to 2000 cu ft per bbl. The most significant production increase occurred in Magnolia Bowles No. 2, southwest diagonal offset to two injection wells. This well changed from about 30 bbl oil per day to about 60 bbl oil per day in six months. Significant water breakthrough occurred in only one well — Magnolia Bowles 4 — which changed rapidly from 40-70 bbl oil per day and 4 bbl water per day to 30-50 bbl oil per day and 100-130 bbl water per day in June 1953 with flush production of not more than a few thousand barrels of oil before water entry. The unaffected wells stabilized at about 10 bbl oil per well per day following the Spraberry shut-in in April 1953. They declined rapidly during 1954 when production of all wells in the area was resumed.

First Test Results

Generalized interpretation of the Atlantic test results is that water entered the tight matrix readily and displaced oil into the fractures but failed to demonstrate economic feasibility of waterflooding since well production rates achieved were typically 2-16 bbl oil per well per day with few exceptions during 1954 after one-two years water injection when gas-oil ratios of affected wells had been reduced the most and the effects of Spraberry shut-in had diminished.

Thorough analysis of the interrelation of production rates, water injection rates, and reservoir and well pressures of the Atlantic test furnishes what may be the real key to declining

natural productive capacity of the Spraberry wells and to the failure to achieve significant production rates generally in this waterflood test. We believe these data indicate the Spraberry fracture openings are pressure sensitive—particularly those near the well bore modified by the hydrafrac treatment. When reservoir pressure is reduced they tend to close and restrict production rate. When reservoir pressure is increased they tend to open and permit high injection and production rates. For example, the three Atlantic wells used for water injection had initial potentials of 42-134 bbl oil per day and they had declined to 7-20 bbl oil per day shortly before water injection started. Each of these wells took about 700 bbl water per day by gravity.

Total oil and gas produced in the vicinity of the Atlantic waterflood test so greatly exceeded that 2100 bbl water injected daily that reservoir pressure continued to decline in every producing well measured. It is believed the fractures continued to contract thus minimizing oil production rate increases even though the fractures became highly re-saturated with oil as indicated by the greatly reduced gas-oil ratios. If water had been injected into many more wells at rates sufficient to restore the reservoir pressure we believe significant oil production rates would have been achieved. Such was the case in the Humble waterflood pilot test.

Humble Pilot Flood

Starting with the concepts of imbibition waterflooding developed by Atlantic research and benefiting from the Atlantic Spraberry pilot waterflood test Humble's production research division extended study of behavior of flooding fractured reservoirs and discovered an additional feature not previously reported in the literature. Their work centered on performance of fractured reservoir blocks as influenced by dynamic effects of water moving in the fractures. Atlantic's research had involved essentially static water in the fractures. Humble found in the laboratory that strongly water-wet fractured sands could be waterflooded effectively if there were sufficient cross fractures oblique to the general direction of flow. In effect the various fractured sandstone segments are flooded simultaneously and the oil production from them is additive.

Requirements essential for successful displacement of oil by this process are threefold: The formation must be strongly water-wet — it will imbibe water; there must be a large number of cross fractures to provide multiple water entry points; and the fluid flow capacity of fractures in the primary direction of flow relative to the fluid flow capacity of the rock must be low enough to permit all the water to enter the matrix of the fractured sand blocks in a distance considerably less than the spacing between injection wells and producing wells.

With belief that all of these requirements exist in the Spraberry, Humble started a pilot test in the Midkiff area in March 1955 using wells as outlined in Fig. 5. The center test producing well was newly drilled in this somewhat depleted part of the field. Its productivity declined rapidly from 377 bbl oil per day initially in January 1955 after a big frac treatment to 70 bbl per day flowing in March 1955 when water injection started and its gas-oil ratio had increased to 8000-10,000 cu ft per bbl. Detailed performance of this well is illustrated in Fig. 6.

Injection of 1500 bbl water per day into each of the four wells surrounding the test well caused very rapid reduction of gas-oil ratio to 700 cu ft per bbl by August 1955 and stabilized the production rate at more than the capacity of the pumping equipment installed. A larger pump was installed and oil production increased to and remained at 200-250 bbl per day through the rest of the year.

The variable production during the first few months of 1956 was caused by tests to determine which of the injection wells had the greatest effect on water production from the test well and to a workover performed to blank off one of the lesser sands a few feet in thickness thought to carry much of the produced water. These tests showed the east-west injection wells had a greater effect on water production than did the north-south injection wells. Water injection has since been largely restricted to the north-south wells.

Oil production has declined from 200 bbl per day in May 1956 to about 10 bbl per day recently as water percentage has continued to increase. Water injection was stopped in the spring of 1958 when 3,800,000 bbl had been injected and the test was terminated. At that time the center test well had produced 118,000 bbl — nearly 1500 barrels per acre for the 80-acre pilot test. A large percentage of this recovery is attributable to the waterflood since the well was drilled into the semi-depleted area and probably had remaining primary reserves of not more than 100-200 bbl per acre at the time of its completion.

Humble Production Increases

Increasing oil production back to 250 bbl per day through waterflooding at rates sufficient to restore reservoir pressure is in sharp contrast with the

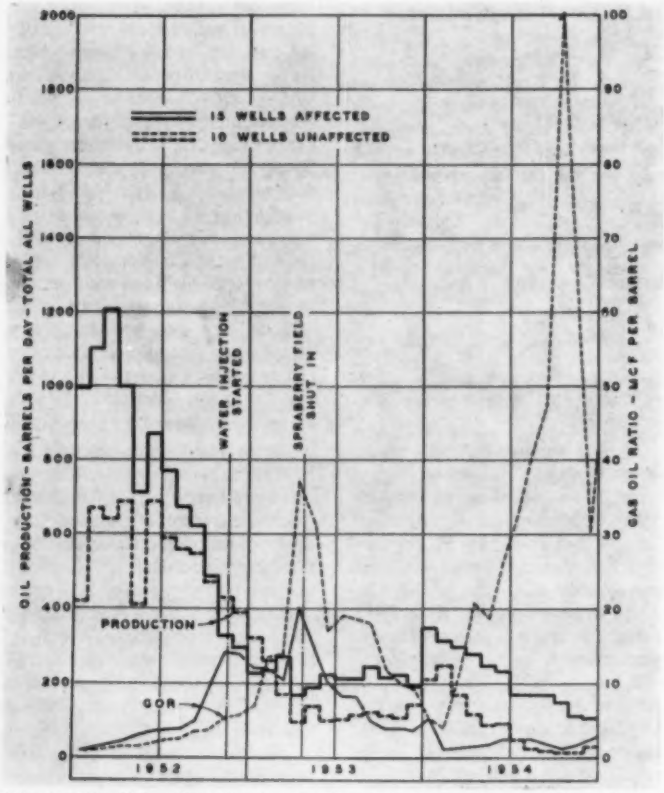
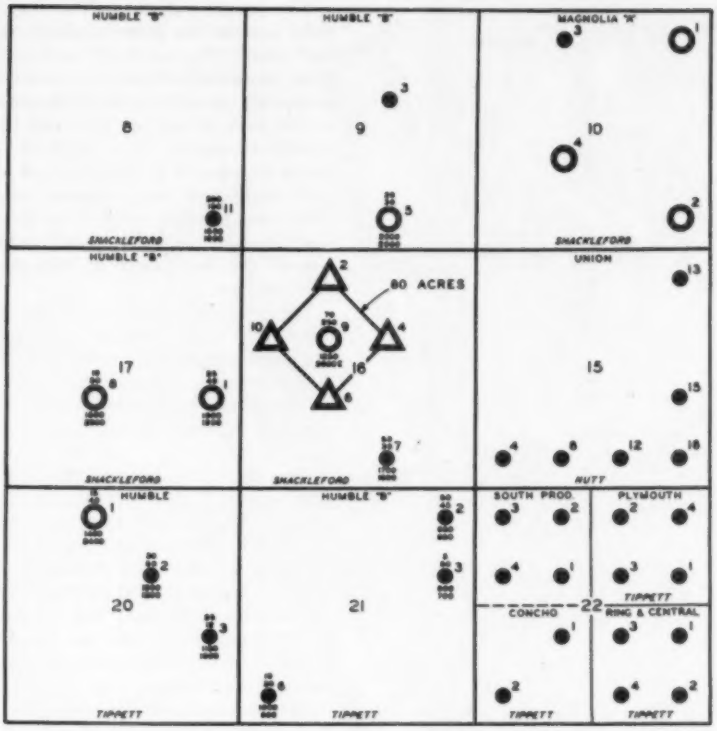


FIG. 4. **Atlantic's pilot flood,** with three injection wells, affected producing characteristics of 15 surrounding wells. Here they are compared with 10 judged unaffected by water injection.



HUMBLE WATER FLOOD TEST

WATER INJECTION WELL

INJECTED WATER IN PRODUCTION

28 PRODUCTION TEST WHEN WATER INJECTION STARTED - BOPD

40 PRODUCTION TEST FALL 1955 - SPRING 1956 - BOPD

1900 RESERVOIR PRESSURE WHEN WATER INJECTION STARTED - PSI

1800 RESERVOIR PRESSURE FALL 1955 - SPRING 1956 - PSI (SONIC MEASUREMENTS)

SCALE 0 1/2 1 MILE

FIG. 5. **Humble's pilot flood,** consisting of four injection wells in the Midkiff area, began in March 1955 and terminated in the spring of this year. Center well in the five-spot pattern produced nearly 1500 bbl per acre, although primary production was estimated at 100 to 200 bbl per acre.

somewhat similar Atlantic field test where fluid withdrawals greatly in excess of water injection caused reservoir pressure to decline in all producing wells. The reaction of this Humble test well to pressure restoration is in agreement with the relation between fracture permeability or opening and reservoir pressure determined previously from the Atlantic pilot test data.

Injection of 1500 bbl water per day by gravity into each of the four Humble wells which had initial potentials of only 38 to 165 bbl oil per day is also in agreement with this principle. Production data of Humble observation wells outside the pilot five spot also confirm this pressure-production relation. Oil production rates and reservoir pressures of these wells measured before and during the waterflood test are included on Fig. 5.

In general the wells northeast and southwest of Humble's water injection showed significant increases in production back to 30-50 bbl oil per day and experienced either stabilization or increase in reservoir pressure. Wells northwest and southeast of injection continued to decline in both oil production rate and in reservoir pressure.

Reservoir Characteristics

Invasion of injected water into producing wells — identified by chemical analysis — was also limited to wells in the northeast-southwest trend. The combination of increase in oil production rate, increase in reservoir pressure and invasion of injected water in this trend indicates the predominant direction of the Spraberry fracture system.

Using analyses on high speed electronic computers, Humble's research engineers have found effective reservoir permeability along the main fracture trend must be assumed to be about 150 times greater than permeability perpendicular to this fracture trend for the calculated times of water breakthrough in the various observations wells to match those actually occurring in the field. This very uneven directional permeability will require detailed study to select wells for water injection and wells for production and will require continuous analysis of performance to properly regulate distribution of water injection and production.

It is essential that lines of injection wells conform as nearly as possible to a single fracture or closely associated groups of fractures along the main fracture trend and similarly that lines of producing wells conform to other single fractures or closely associated groups of fractures. If injection and producing wells happen to lie in the same major fracture some direct channeling of water to producing wells will undoubtedly occur such as happened in the Magnolia Bowles 4 well in the Atlantic pilot test.

With the freedom to alter injection and production patterns that will come with large scale unit operation the risk of extreme un-correctible channeling is slight though because it occurred in only one producing well out of 30-50 wells in the two pilot flood tests conducted.

Future Flood Possibilities

Preliminary estimates of operating expense and recovery indicate waterflooding the Spraberry will not support extensive drilling of new wells but it can be highly profitable in areas already completely developed. Indications are favorable that the flood can be effective with wells drilled on 160-acre spacing.

It is believed the results of these pilot waterflood tests indicate favorable economic return with extensive flooding of the Spraberry and in addition we believe the unusual features of flooding created by the directional fracture system make imperative that the operation be conducted as very large scale units. This is necessary to permit proper selection of lines of injection wells and lines of producing wells over distances of many miles and to permit restoration of reservoir pressure without disproportionate leakage of water from the flooded area to adjacent unflooded areas.

The San Andres formation appears capable of furnishing all the water necessary for flooding the entire Spra-

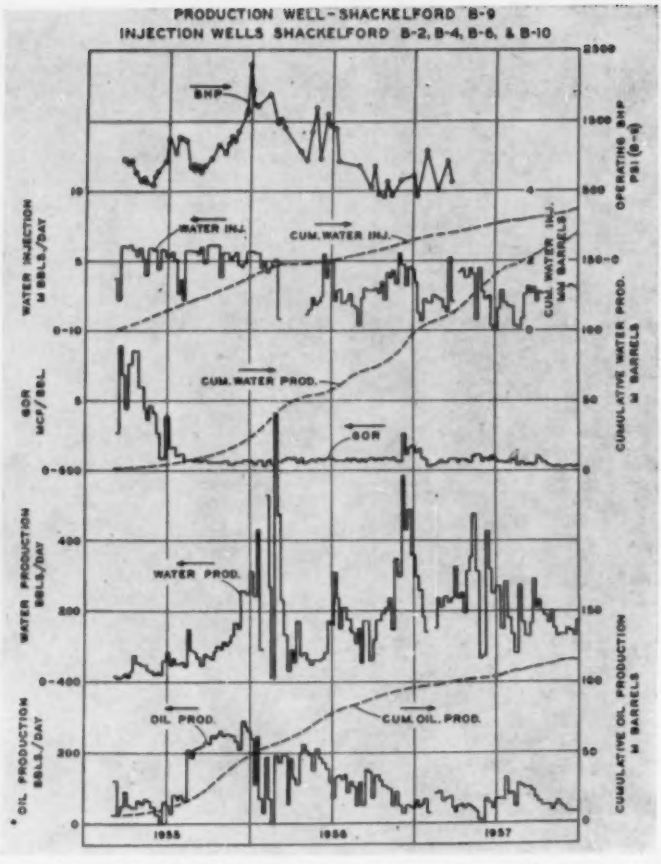


FIG. 6. **Humble's waterflood performance.** Extremely variable production in early months of 1956 was caused by a test to determine strength of different injection wells, and to a well workover.

berry through high-capacity supply wells. One San Andres supply well furnished water at rates up to 7000 bbl per day for the Humble pilot test without measurable decline in static reservoir pressure during withdrawal of 3,800,000 bbl of water. A one-day test of Sohio's Davenport B-1, NE NE Section 2, Block 37, T-5-S, yielded 12,000 bbl water per day with just 45 psi drawdown. Volumetric analysis of the San Andres from gamma ray, neutron, and electric logs indicates adequate water volume will be available to flood the entire Spraberry.

Cost

Preliminary studies of equipment and operation indicate incremental investment will average $135,000 per section with flooding on a pattern involving 160-acre spaced wells. These costs assume conversion of many wells to water supply that are in excess of those drilled on 160-acre spacing but do not include the costs of new wells which may be required in some of the incompletely developed parts of the Spraberry. Total operating cost including water supply, oil production and all overhead features is estimated to average about $2500 per section per month when maximum capacity injection and production are achieved.

With prospective secondary recovery of 1500 bbl per acre and these estimates of investment and operating expense, operating profit is forecast to range from $1,400,000 to $2,000,000 per section or $10.00 to $14.50 profit per dollar invested with the range depending upon oil production rates achieved during the flood.

Sohio Unitization Plan

Recognizing the pending abandonment of many Spraberry wells which are approaching the economic limit of operation and having evaluated waterflooding much as you have heard here today, Sohio Petroleum Company undertook the impressive task of attempting unitization of a very large part of the Spraberry for waterflooding.

Operators of properties within many miles of Sohio's 21 section Driver area lease block were invited to a meeting in Midland, Texas on September 25, 1957 to hear our analyses and proposals. With this start necessary committees were formed and numerous studies made of the technical, economic, business and legal questions involved.

The progress made in the ensuing eight months has been excellent such that nearly 90 percent of working interest owners in a 100-section area have tentatively agreed to unit participation on the basis of surface area and have tentatively agreed on a basis of deferred adjustment of investment of tangible equipment and required workover costs pending result of a Texas-size nine-section "pilot flood" which will be the first phase of waterflood development.

We hope the preparation of the unit agreement and operating agreement can be accomplished within the next two or three months such that they can be submitted to royalty owners and working interest owners as soon as possible.

Tentative boundary of this unit is outlined on Fig. 1. Potentially many additional large Spraberry waterflood units may be organized. One of these, west and northwest of the Sohio section, is being sponsored by Humble Oil and Refining Company. The first meeting of operators in that area was held April 22, 1958 at which necessary committees were formed and the various studies directed toward unitization are now in progress.

Others to Follow

Many other operators have indicated their desire to organize and operate units in other areas contiguous with the proposed Sohio unit.

These include Cities Service to the southeast, Tidewater to the south, Phillips to the southwest and Magnolia to the northwest. While none of these latter unitization efforts have reached the organizational stage it is quite likely that most of these units will be formed and the Spraberry flooded.

Such is the development of the Spraberry formation both during primary production phases and during waterflooding as exemplified by two field pilot tests until now. Primary recovery, averaging only 500 bbl per acre, is just 6-8 percent of oil in place. Waterflooding may increase this by 1500 bbl per acre if performed on a very large scale basis where sufficient water can be injected to restore reservoir pressure to 2000-3000 psi and in units of 50-100 sections where the freedom will exist to properly select and modify the pattern of injection and production to force flooding across the grain of the main northeast-southwest oriented fracture system. Considerable progress has been made toward organizing at least two large Spraberry waterflood units. The few remaining features of unitization will probably be resolved shortly such that unit agreements and operating agreements can be submitted to royalty owners and working interest owners in the near future. ★ ★ ★

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THE PERMIAN Basin of West Texas and New Mexico is noted for its multiplicity of oil and gas traps. The nature of these traps vary from a simple anticlinal fold to the complex stratigraphic, or depositional pinchout.

One of the most prolific, and probably the least understood, of all the various types of Permian Basin oil traps is the truncation. Any truncation is the result of "uplift and erosion." A trap is formed by the truncation of a potential reservoir bed as it is weathered and eroded. Later sealing of the reservoir by an impermeable cover completes the trap. Local structure is not necessary for the entrapment of hydrocarbons.

Since 1939, there have been several important oil and gas-condensate finds completed from truncated traps. These discoveries range from the western flanks of the so-called Central Basin Platform eastward to the Siluro-Devonian truncation line in central Howard County. All Pre-Pennsylvanian rock units that produce oil or gas on structure also produce from truncations and, in many cases, the truncation type trap has better reservoir characteristics than its structural counter-part.

First Truncation Discovery

The Apco-Warner field of Pecos County, Texas, discovered in June 1939, by the Anderson-Prichard Oil Company et al No. 1 Masterson, was probably the first significant discovery made from a truncation type trap in the Permian Basin area. The nature of the trap is an up-dip termination of the Ellenburger reservoir rock by truncation. The truncated Ellenburger varies from being almost flat to having scarp-like relief. It is overlain, unconformably, by beds of Middle Permian age. Fig. 1 and 2 show a schematic cross section through two portions of the field and Fig. 3 is a paleogeologic map on the top of the Pre-Pennsylvanian erosional surface.

Average pay thickness in the Ellenburger is 100 ft, with a total oil column of 775 ft. The reservoir rock is a weathered dolomite with very good porosity. It should be noted that porosity in most truncated traps is relatively high, due to weathering and secondary porosity development.

The 46 wells in this field have produced in excess of 4000 bbl of oil per acre from a depth of less than 5000 ft. Average production in 1956 was 6800 bbl of oil per well. Average per well

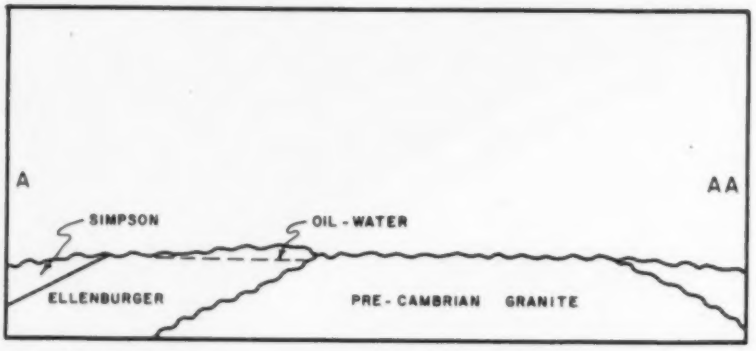

FIG. 1. Cross section A-AA through the Apco-Warner field, showing Pre-Permian truncation. The unconformity is overlain directly by Middle Permian.

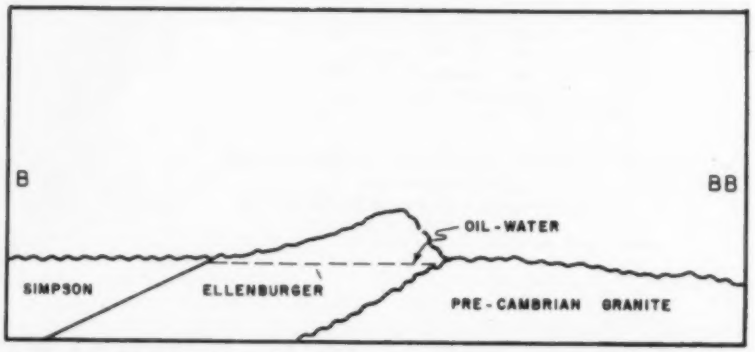

FIG. 2. Cross section B-BB through the Apco-Warner field. This section shows both the truncated formations and the relief on the unconformity.

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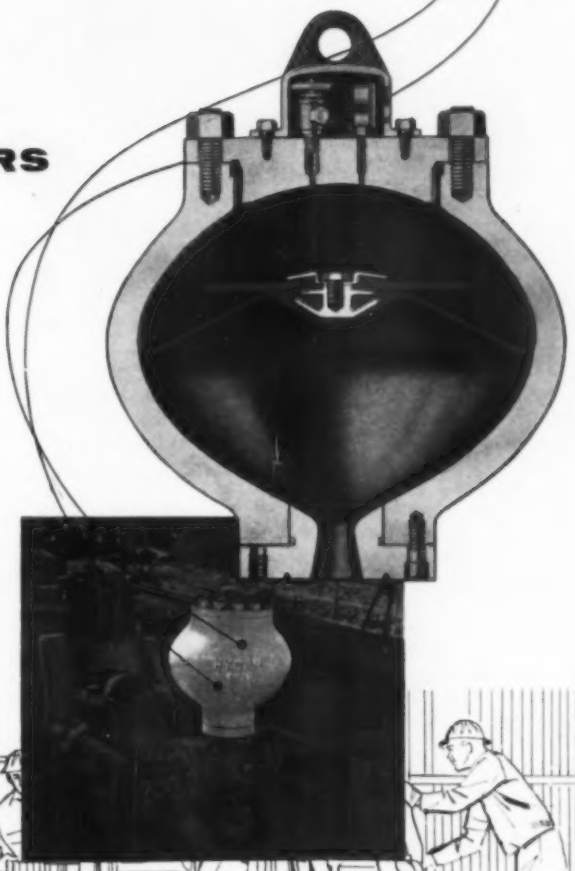

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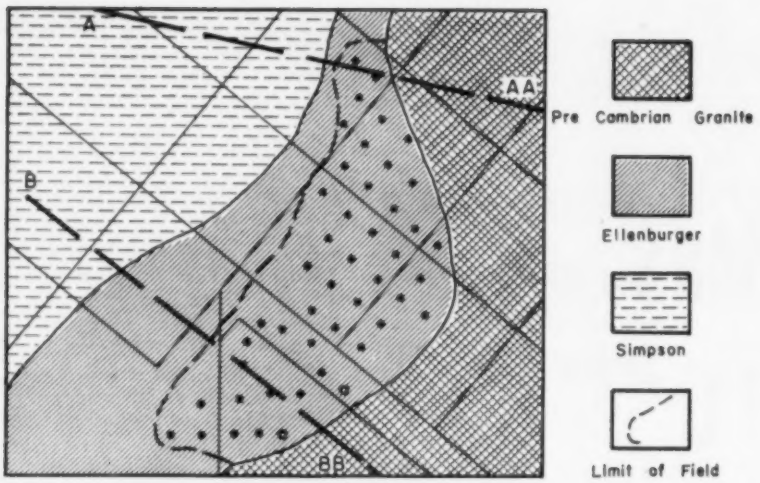

FIG. 3. Paleogeologic map of Apco-Warner field area, on top of the Pre-Permian unconformity.

production to January 1, 1957 was 168,000 bbl of oil.

Truncations of Fusselman, Montoya

The Abell (Fusselman-Montoya) field of Pecos and Crane Counties, Texas, was discovered in 1948 by the Magnolia No. 2 Lutz. The character of the trap is a truncation of the Fusselman and Montoya dolomites overlain by unconformable Permian beds. Pre-Permian weathering produced excellent vuggy-to-cavernous porosity in both formations. The Fusselman-Montoya reservoir is in a graben (Fig. 4 and 5), and this down-faulting protected the reservoir rock from complete removal by the period of Pre-Permian erosion. The Fusselman-Montoya rock units abut against eroded Simpson on the east, west, and south sides of the graben (Fig. 5).

Average thickness of the reservoir is 100 ft with an oil column in excess of 270 ft.

The 36 wells in the field have produced an average of over 150,000 bbl of oil to date. Average per-well production in 1956 was approximately 17,200 bbl of oil. To date, this field has recovered 4100 bbl of oil per acre. Average depth to the reservoir is 5000 ft.

Truncated Devonian Chert

The Three Bar (Devonian) Field of Andrews County, Texas, produces from a truncated basal Devonian chert section. This field, along with Block 11 (Devonian) to the north, and West Andector (Devonian) and West Goldsmith (Devonian) to the south, is a direct result of the truncation of the lower Devonian "Three-Bar chert" zones on the west flank of the major Goldsmith - Andector - Embar - Martin fold complex (see east-west cross section through Embar-Three Bar field. Fig. 6).

The Three Bar field is the oldest of those mentioned, being discovered in 1945. Its productive history should be noted.

The 59 wells in the Three Bar field had produced 12,056,731 bbl of oil as of January 1, 1957. This is an average per well recovery of over 220,000 bbl of oil to date. Average production per well for 1956 was in excess of 20,000 bbl, and per-acre recovery to date is approximately 5500 bbl.

Average pay thickness is 55 ft with an oil column of 70 ft. The reservoir is predominately weathered chert and limestone and has excellent porosity and permeability, as evidenced by the fact that after 12 years of oil production, 80 percent of the wells are still flowing. The average depth to the pay is 8300 ft.

Sandstones

Truncation type traps are also found in the various sandstone units within the Simpson group. Both the upper and lower McKee sandstone horizons and the Waddell and Connell sandstone produce from truncations.

The porosity of this type of truncated reservoir is similar to that found where the sandstone units produce "on structure," since the sandstone units will not have secondary "weathered porosity" developed, as in a carbonate rock. In fact, the secondary deposition of a carbonate cementing material may, in some cases, decrease the sandstone porosity at or near the truncation.

The recently discovered Running W (Waddell) field of Crane County, Texas, produces from a truncated Waddell sandstone reservoir. The Waddell and Ellenburger horizons produce "on

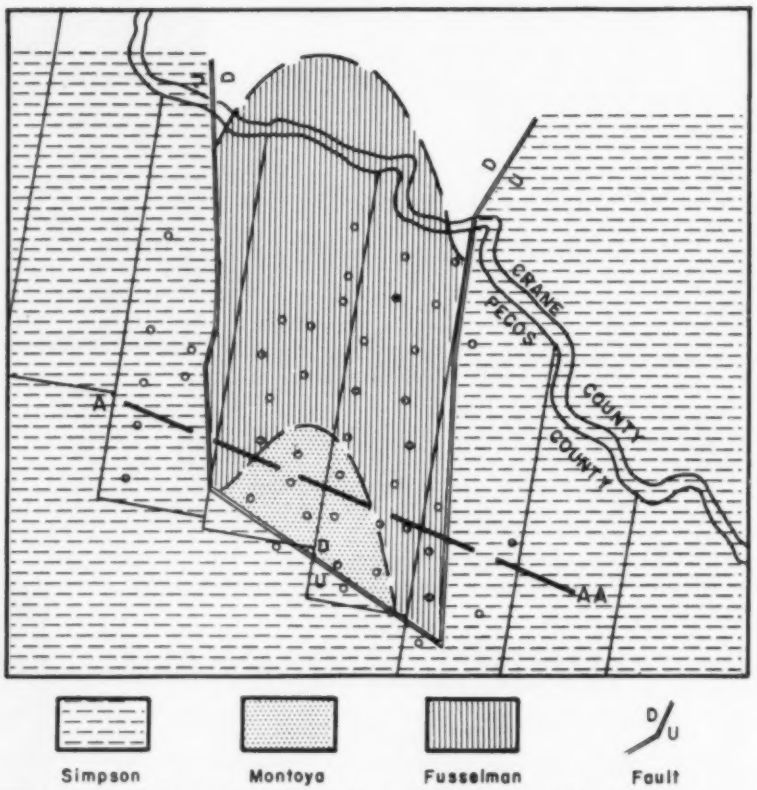

FIG. 4. Paleogeologic map of the Abell field, showing Pre-Permian erosional surface.

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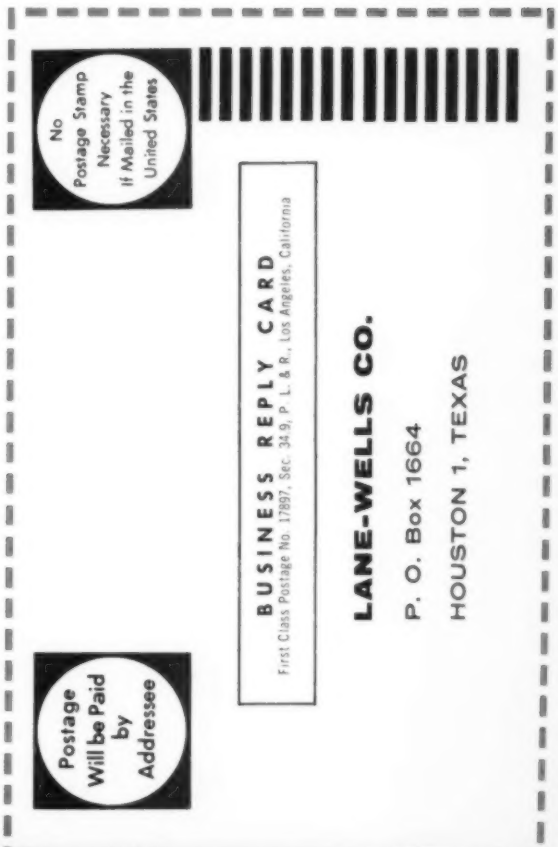
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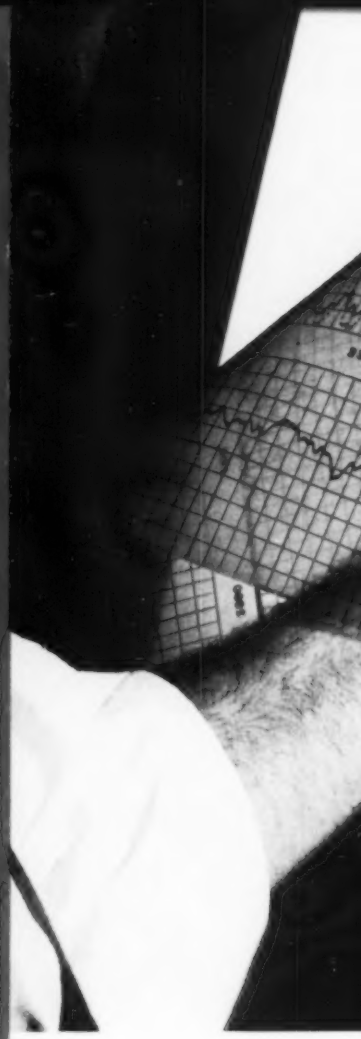

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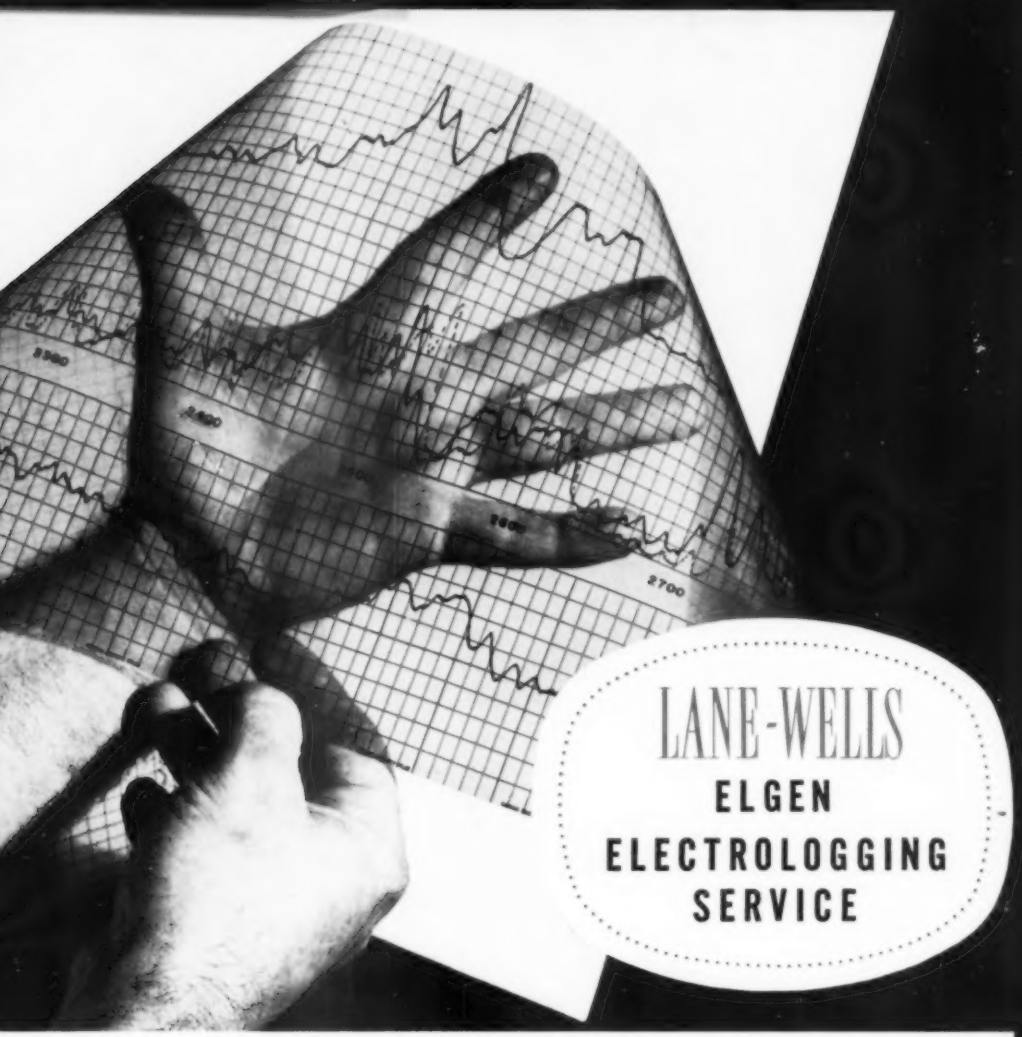

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structure" in the Block 21 field, some four miles to the west. The Running W (Waddell) field produces from some 65 ft of Waddell sandstone pay which has been truncated up-dip by Pre-Permian erosion. (See Fig. 7).

The Waddell pay section is at an approximate depth of 6100 ft and the wells completed to date potential for over 300 bbl per day, flowing. The total oil column is in excess of 200 ft.

The Running W (Waddell) field was discovered in early 1957 and the extent of the field is not presently known. Data as to the per acre recovery to date is inconclusive. Production data and per acre recoveries for several of the older truncated Simpson sandstone reservoirs are listed in Table 1.

TABLE 1.

Field	County	Pay	No. wells	Cumulative 1-1-57	Production 1956	Recovery per acre	Depth
Abell	Pecos	Waddell	59	9,718,120	351,248	4100	5300
Tucker	Crane	McKee	13	990,776	83,015	1900	5400
Abell (SE)	Pecos	McKee	2	340,224	27,299	4250	5200
Sand Hills	Crane	Waddell	33	5,708,995	251,793	2400	5700

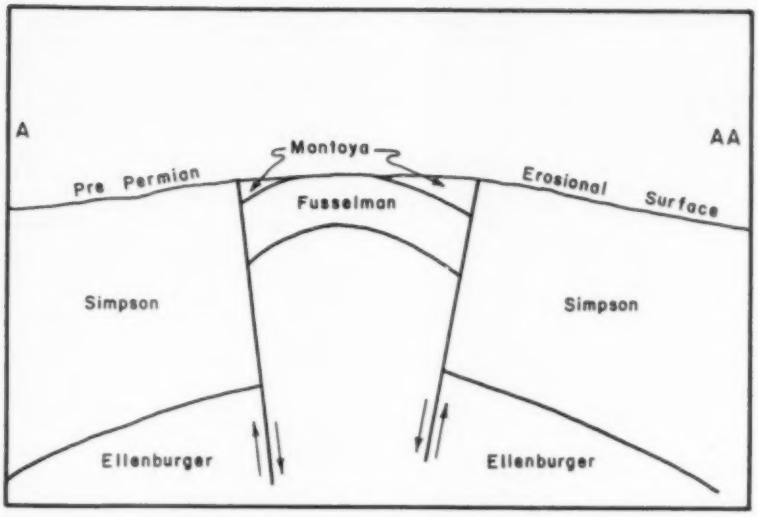

FIG. 5. Cross section through A-AA showing graben faulting in the Abell field.

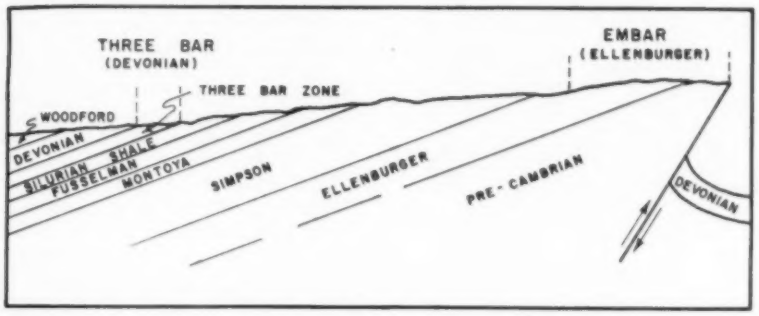

FIG. 6. East-west cross section through the Embar-Three Bar field, showing truncation of the Pre-Permian section.

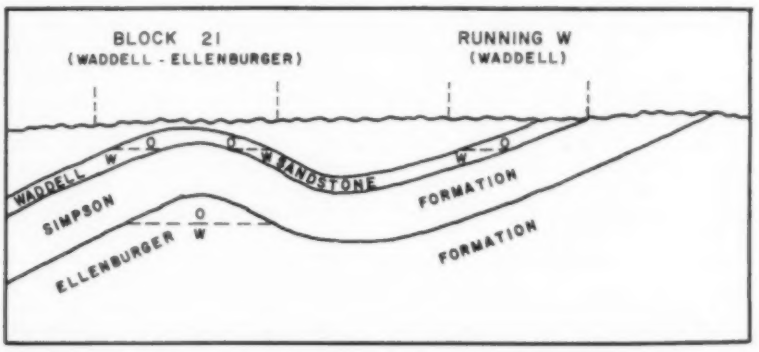

FIG. 7. East-west schematic cross section through Block 21 (Waddell Ellenburger) field and Running W (Waddell) field, showing the Pre-Permian truncation overlain by Middle Permian.

All these fields are on the so-called Central Basin Platform and from this, one might assume that the truncated trap is limited to that area alone. This is definitely not the case. The up-dip truncation of Siluro-Devonian limestone in Howard County forms an excellent oil reservoir. To date, several fields have been discovered in this truncated zone, with the best known being the Southeast Luther field in Howard County, Texas.

The Southeast Luther field was discovered in September of 1953, and to date has produced in excess of 2400 bbl of oil per acre from 34 wells. The pay zone is the truncated Siluro Devonian (Fusselman) limestone section. The pay zone thickness averages 25 ft in the field and is found at a depth of about 9800 ft. Average production per well to January 1, 1957, was 73,500 bbl of oil, with the average production in 1956 being 32,000 bbl of oil per well.

The Garden City field in Glasscock County and the Big Spring (Fusselman) field in Howard County are other fields presently producing from a truncation type trap in the eastern portion of the Midland Basin.

Producing fields discussed are only a few of the better known truncation type traps. The TXL (Devonian) in Ector County, Block 11 (Devonian) in Andrews County, Dollarhide (Devonian) in Andrews County, Pecos Valley (Fusselman and Montoya) in Pecos County, Keystone (Devonian) in Winkler County, Block B-27 (Connell) in Crane County, and Cordova Lake (Devonian), also in Crane County, are others that warrant mention.

From this data, one would conclude that a truncated reservoir is certainly worth looking for, both with regard to recovery and depth. The truncated trap is no more difficult to explore for than a normal structural trap, and in most cases, the rewards are greater. Detailed subsurface geological and geophysical studies of the many known areas of Pre-Pennsylvanian truncation in the Permian Basin area reveal numerous truncation type prospects. Discoveries resulting from the drilling of these "truncated traps" will greatly increase the known oil reserves of the Permian Basin. ★ ★ ★

Union's offshore well in Louisiana

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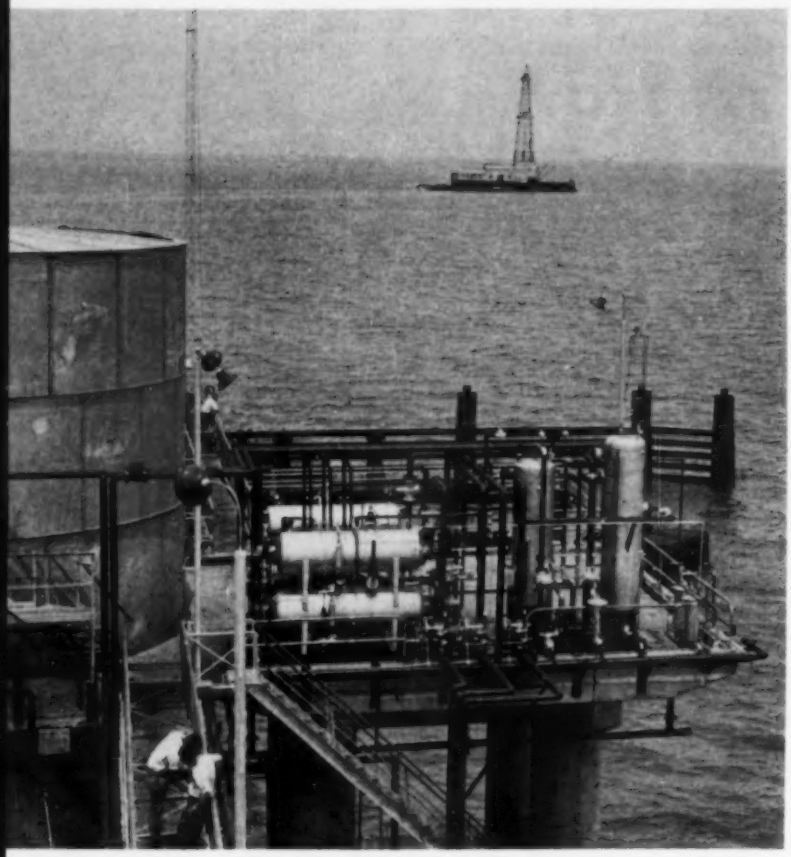

Looking at Gracey-Hellums' fast drilling Barge 3 from Union of California's Caillou Island production platform in Timbalier Bay.

"Snowbank" drilling or not — 13,778 ft in 14 days and 3 hours is a record in anybody's book!

Ed Sands
Union Oil Company of California

ABOUT 60 MILES southwest of New Orleans is Timbalier Bay, a 35-mile wide indentation in the Louisiana Coast line. The bay is shallow, nowhere much more than 10 ft in depth. One of several islands located in the bay is called Caillou Island. In shallow water just east of the island is an important new oil field being developed by Union Oil Company, known as Caillou Island field. More than a dozen wells so far drilled in this offshore domain are producing oil, and development work is being continued.

June 4, 1958, Well No. 14 in the Caillou Island field was drilled to its projected depth of 13,778 ft. Geologists who sat in on the completion were reasonably sure they had another good oil well. However, petroleum engineers on the job began to wonder if there wasn't something more to the story than just oil.

The well had been spudded at 2:30 p.m. on May 21. The depth of 10,500 ft was reached May 28 at 1 a.m., an elapsed time of six days, 10½ hours. Drilling was then continued to the projected depth of 13,778 ft. This goal was reached at 5:30 p.m. on June 4 — an elapsed time of 14 days and three hours from the time the well was spudded.

The drillers began to search their memories. They could recall some pretty fast drilling performances in their day, but nothing to match this one. A thousand feet of hole per day is infrequently accomplished even in shallow tests; Well No. 14 averaged nearly a thousand feet a day all the way down to 13,778 ft. The engineers scanned records, compared notes, made inquiries. Nowhere could they find evidence of such a deep well being drilled in 14 days. To the best of everyone's knowledge, Well No. 14 was drilled in world's record time!

A drilling speed record may seem unimportant. In this era of deeper and deeper exploration, however, it is imperative that the oil industry place greater emphasis on reducing the cost of drilling and completing wells. Drilling speed is equivalent in most cases to economy, for the overall cost of a well is usually proportionate to the time required to complete it. This speed record may therefore also be a record low cost for drilling a deep well in the Timbalier area of operation.

Gracey-Hellums Corporation, who contracted to drill the well on State Lease 2826 for Union Oil and Louisiana Land & Exploration Company, were at no time aiming for a world's speed record. They merely wanted to win a continuity of work in the highly competitive drilling game by doing a good job — supplying their customer the most drilled hole in the least number of days. Their equipment, though excellent, was not the largest or most powerful available. The drilling crews, highly skilled and coordinated, were not specially picked. True, the formations where the record was established have a reputation among drilling men for "snowbank drilling"; nevertheless, no other well in the area had been drilled at comparable speed.

President Earle C. Hellums, of Gracey-Hellums Corporation gives full credit to the crew. The toolpusher was Marion Cook, the relief toolpusher E. S. Banks. The drillers were R. Guillatte, E. C. Rogers and E. G. Gros. Union

Reprinted from July 1958 issue of "Seventy-Six," employee publication of Union Oil Company of California.

Time

Oil Company petroleum engineers assigned to the project were Ty Brinker and Joseph R. Prosser Jr.

In questioning Marion Cook relative to this extremely high rate of penetration, we were told that the record was largely "a good run of luck." The crew encountered no serious troubles to slow them down. They made good straight hole — no sloughing or tightness. They encountered no drill pipe or bit trouble. Everything proceeded without a hitch.

Anyone who has ever drilled an oil well, however, knows that "good luck" is just a modest synonym for skill and good management. A study of Well No. 14's drilling log tells the true story: Excellent drilling hydraulics were maintained. Good use of the right mud aided fast penetration. High rotary speeds were used at shallow depths. Bit loading was fairly high for the Gulf Coast. Bits were pulled at the right time. Equipment was first rate. The crews were highly skilled, fast, careful, conscientious.

The rig used to drill this well is a large diesel-powered drilling barge. Its drawworks are driven by three 520 hp diesel engines with a separate 260 hp twin-diesels driving the rotary table. The pumps consist of one 700 input hp pump, a 500 input hp pump and a 140 input hp mud mixing pump.

The casing program: 16-in. conductor pipe was driven to 54 ft; this pipe was pulled after the 10¾-in. casing was cemented. A 15-in. hole was drilled to 2425 ft and 10¾-in. casing was cemented at 2419 ft with 625 sacks of common cement. A 9⅞-in. hole was drilled from this depth to 13,778 ft, where 7-in. casing was cemented.

It is interesting to note that the well never deviated more than 1¾ deg from vertical. Examination of the records will show that 12 drill collars were used down to a depth of 12,370 ft, at which depth three 7¾-in. drill collars were removed. No hole trouble was encountered in this well at any time. A successful electric survey was conducted to 13,778 ft, and no trouble was encountered in running the 7-in. casing to this depth.

Some luck perhaps, but a whale of a good drilling performance! ★ ★ ★

Living quarters, lashed to concrete piling as insurance against hurricanes, are located at the Caillou Island field production installation, near the Gracey-Hellums drilling barge.

Full credit for the fast penetration record goes to the crew, says Earle C. Hellums, president of Gracey-Hellums Corporation, who drilled the well.

Toolpusher Marion Cook, center, tells Union engineers Bill Alexander, left, and Joe Prosser that the record achievement was partly due to "a good run of luck."

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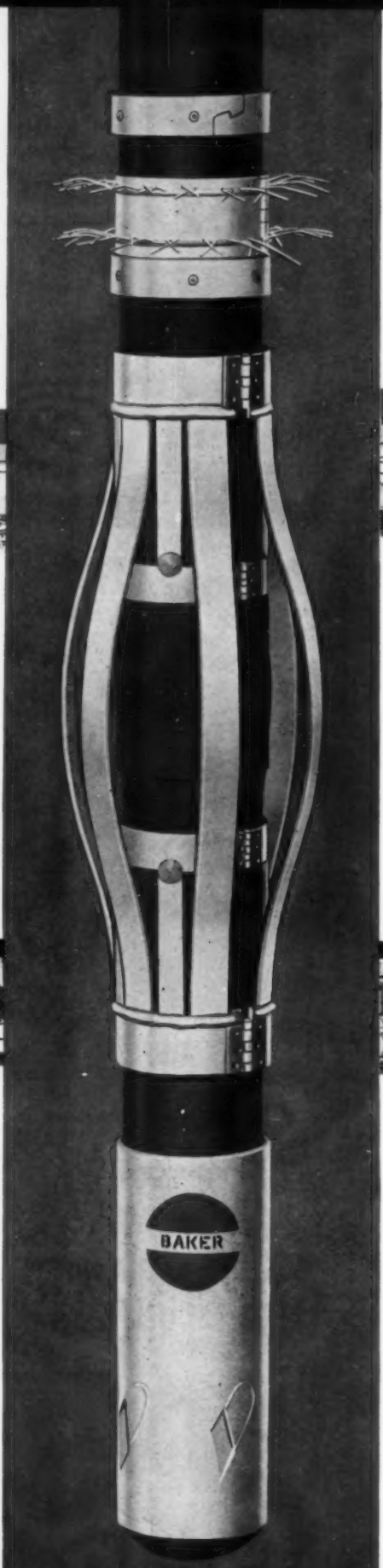

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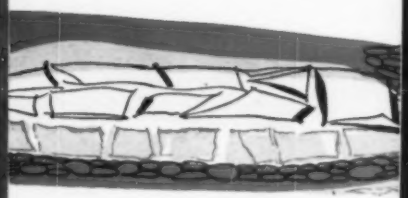

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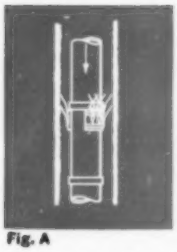

Fig. A

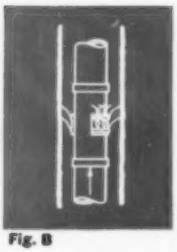

Fig. B

Fig. C

Fig. A Scratcher wires, retained by integral hinged mounting, swing freely upward and do not remove mud cake while running in.

Fig. B Even when casing is lifted out of the slips, the entire Scratcher remains stationary. Only when reciprocated, and

Fig. C ...only at the cementing area does the "scissors" action of the crossed wires remove mud cake.

Baker Scratchers remove mud cake only from the cementing area; this "controlled scratching" protects productivity.

While running in, the scratcher wires automatically swing upward along the casing, where they are safe from damage; permit free, unrestricted lowering of the casing; and do not disturb or remove mud cake. There is no danger of "balled-up" mud collecting on the scratcher wires to plug the annulus and contribute to pressure surges with possible "mudding-off" of the producing zone. Only when the cementing area is reached and the casing is reciprocated do the double rows of strong "crossed" spring wires automatically reach out, dig in, and remove the mud cake with efficient "scissors" action.

Fig. D

Fig. E

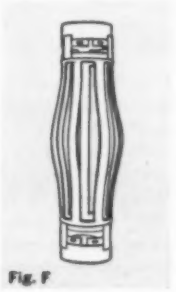

Fig. F

Fig. D "Extended" Range HINGE-LOK Baker H-25 Casing Centralizer. Product No. 9113.

Fig. E "Normal" Range HINGE-LOK Baker H-20 Casing Centralizer, Product No. 9112.

Fig. F "Slim Hole" SOLID-RING Baker G-15 Casing Centralizer, Product No. 910-G.

Baker Centralizers assure cementing clearance. "No-scrape" design prevents "balling", plugged annulus and stuck casing.

The QUALITY of Baker Casing Centralizers starts with "sled-runner" springs made of high quality spring steel—tested and pre-set by flattening in hydraulic presses—then butt-welded to collars to form a unit of great strength. Pre-setting of the springs to the pre-calculated optimum bowed height enables each centralizer to pass tight spots or dog legs without damage to the assembly, and ensures GREATER CENTERING FORCE for maintaining annular clearance for cementing.

Baker Centralizers do not remove mud cake which could plug the annulus, contribute to pressure surges and restrict productivity.

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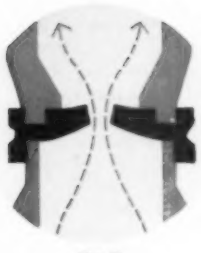


Fig. G

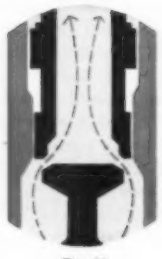


Fig. H

Fig. G Variable FILL-UP Valve as used in FLEXIFLOW Equipment.

Fig. H Variable FILL-UP Valve as used in DIFFERENTIAL Equipment.

Baker Fill-Up Equipment saves time in running casing, but does not create pressure surges that reduce productivity.

Destructive pressure surges—often created when casing equipped with conventional floating equipment is lowered into the well—can now be avoided. The Variable Valve in either Baker DIFFERENTIAL or Baker FLEXI-FLOW "Fill-up" Shoes and Collars, permits casing to fill from the bottom up; eliminates expensive, time-consuming surface filling; and automatically coordinates the *rate of fill* with the *rate of lowering* to AVOID high pressure surges. Baker FILL-UP Equipment permits the casing to be lowered at normal rates, saving rig time and reducing danger of sticking the pipe; chances for successful primary cementing are increased; formations are protected from high pressure surges which can impair their productivity.

Part 2 and Conclusion

P 538.22

ABC's of Treating and Handling Injection Water

Basic concepts for surface systems, including methods, filter specifications, rates, turbidity factors and an analysis of oil field brines

Part 2 — Techniques of Backwashing and Operating Filters

Lawton L. Laurence and Wayne E. Leuszler
Black, Sivalls & Bryson, Incorporated
Oklahoma City, Oklahoma

IN the following article the authors continue their discussion of water treating by presenting the techniques of backwashing and operating filters in water treating systems.

BACKWASHING

What Is Backwashing?

Backwashing is the reverse flow of water through the filter to remove the accumulated suspended matter from the filter bed surface.

Why Backwash Filter Beds?

Filter beds are backwashed to remove the suspended materials before they penetrate through the bed into the injection line or before the layer of suspended matters is sufficient to restrict or reduce flow of water through the filter. Therefore, it is very important in filter operation that proper backwash techniques be followed to insure a clean filter bed.

Unless proper backwash is accomplished the life of the bed will be shortened due to the progression or penetration of suspended particles deep into the bed to cause contamination.

During filtration, the smaller particle of filter media tends to penetrate or migrate into a lower layer of larger particles due to the downward flow of water. During backwash when the flow of water is reversed, the entire upper section of the filter bed is fluidized or lifted. The smaller particles of less weight are lifted out of a layer of larger particles of greater weight and are carried up until the small particle more or less finds its own level. By this phenomena the filter bed is hydraulically regraded. However, backwash rates are important. If backwash rates are excessive, filter media will be washed out and lost. If backwash rates are too low, the bed will not be cleaned or regraded.

Frequency of Backwash

Filters may be backwashed as often as every eight hours or only once a week. The frequency of backwash is dependent on the quantity and characteristics of the suspended solids entering the filter bed.

Filters may be backwashed whenever the pressure drop or differential across the bed is approximately 60 to 80 in. of water or less (2.2 to 2.9 psi) for permeable plate filters with anthrafilt to approximately 100 to 120 in. of water (3.6 to 4.3 psi) for graded bed filters with sand.

Where filters are operated at constant pressure, operators backwash the filters whenever the flow rate decreases to a certain limit.

Backwash Rates

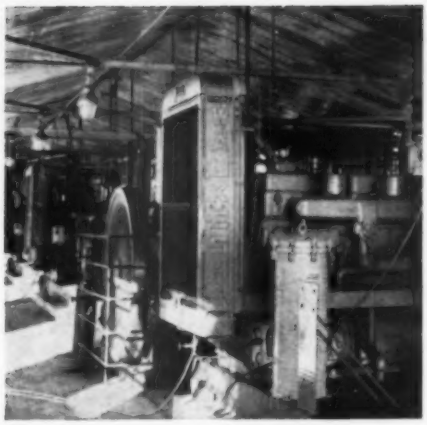
Backwash rates must be sufficient to clean the filter bed without loss of filter media. Backwash rates depend on the size, shape and density of the filter media. Backwashing the filter bed should be done at a velocity sufficient for 150 percent expansion of the filter media. Average backwash rates for most filter installations are 7.5 to 10 (gal per min per sq ft of filter area) for anthrafilt and 12.5 to 15 (gal per min per sq ft) for sand. However, actual backwash rates of filter beds under actual flow conditions must be determined by the operator after the filter is installed.

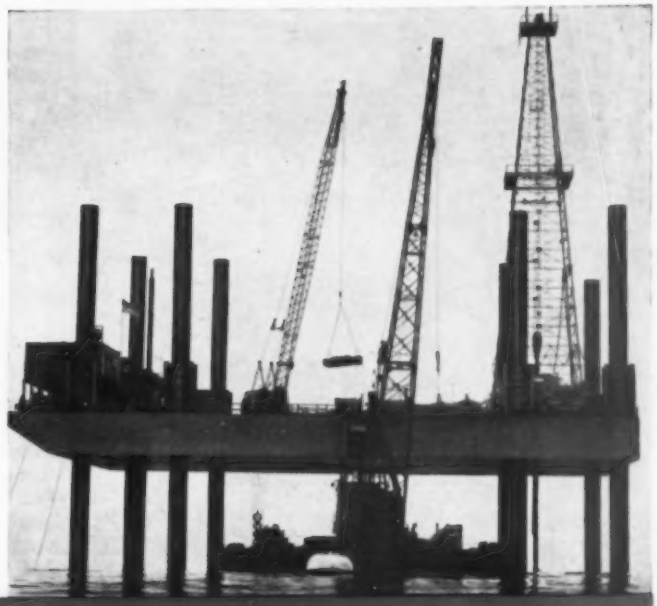
It is the belief of some operators that a prolonged wash of 30 to 45 minutes at a lower backwash rate of 5 gal per min per sq ft is as effective as a higher rate of 10 to 15 gal per min per sq ft for 10 minutes.

At lowered backwash rates the upward velocity of the wash is insufficient to carry out the suspended solids that were filtered out of the water. As soon as backwash stops, the solids will settle back on the surface of the filter bed. The method of prolonged wash at lower rates should be discouraged because of the excessive waste of wash water.

By increasing the backwash rate until the suspended solids are washed out, but filter media is not carried out, generally a filter bed can be washed clean in 5 to 8 minutes. If the bed cannot be cleaned in 10 to 12 minutes then adjustments should be made in chemical feed, filtering rates, or perhaps additional filtering or treating equipment is needed.

To facilitate backwash and eliminate guess work in maintaining the correct backwash rate throughout the backwash cycle, the use of optional backwash control equipment is recommended. The backwash rate can be accurately regulated by installing an orifice plate assembly or rate-of-flow





WAUKESHA

World's Finest Oil Field Engines

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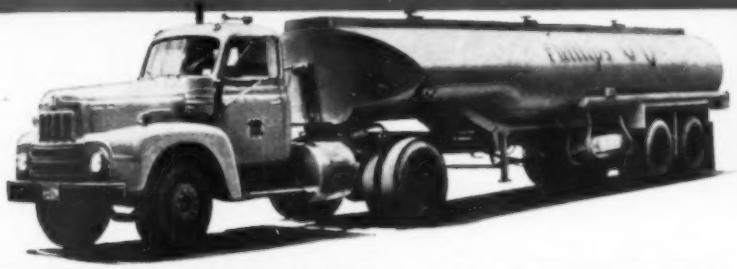

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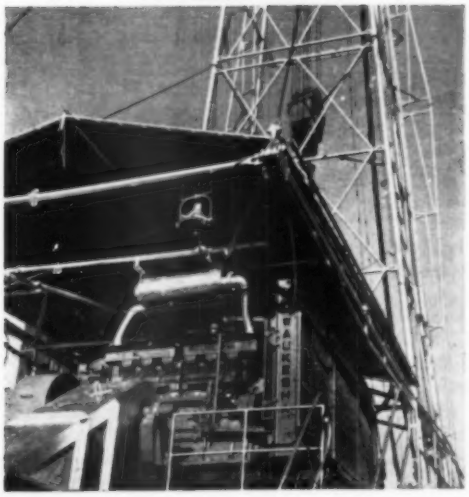
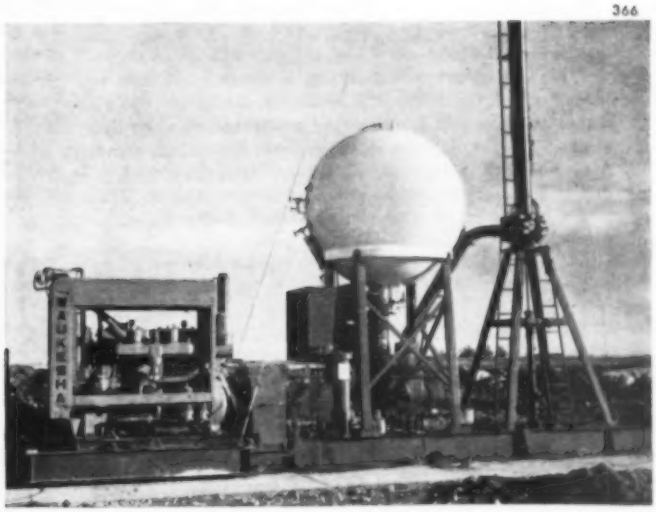




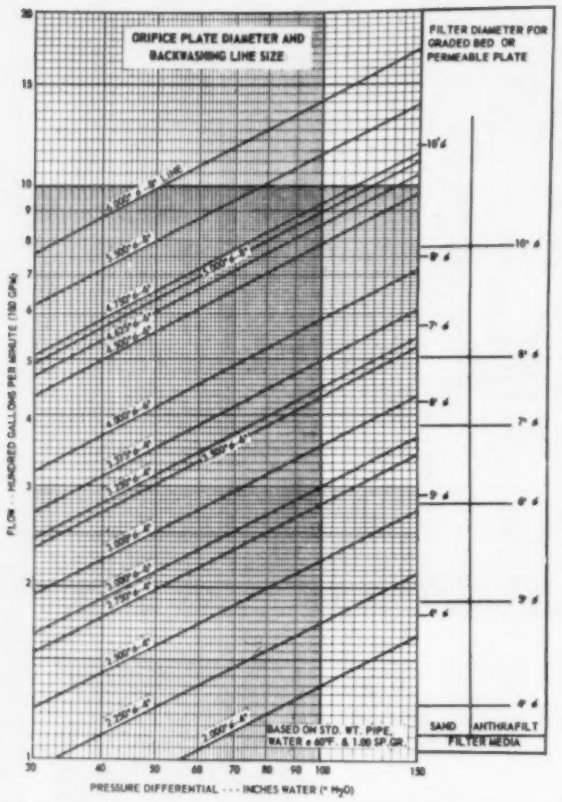

ORIFICE PLATE DIAMETER AND BACKWASHING LINE SIZE
FILTER DIAMETER FOR GRADED BED OR PERMEABLE PLATE
FLOW - HUNDRED GALLONS PER MINUTE (100 GPM)
PRESSURE DIFFERENTIAL - - - INCHES WATER (" H2O)
BASED ON STD. WT. PIPE, WATER @ 60°F. & 1.00 SP. GR.
SAND
ANTHRAFILT
FILTER MEDIA

FIG. 1. **Backwash rate** can be determined with this nomograph by using type and size of filter media installed in the system.

indicators in the backwash line. With pressure differential recorders or indicators and orifice plates, the rate can be determined from Fig. 1.

Enter the right side of the graph with the type of filter media being used; for example, an 8-ft diameter permeable plate filter with anthrafilt or an 8-ft diameter graded bed filter with anthrafilt would require a 4.000 in. diameter orifice plate in a 6-in. standard backwash line. The backwash rate would be 500 gal per min at 73 in. of water on the differential pressure indicator. These same filters with sand would require a 4.500-in. diameter orifice plate in a 6-in. line. The backwash rate would be 750 gal per min at 90 in. of water.

One of the cheapest and most unique methods of determining flow rates is by maintaining a determined head of fluid over a weir section in the backwash discharge line.

Usually the backwash discharge is released in a settling pond or settling tank some distance from the filters; therefore, a sight glass with removable glass bowl should be installed in the backwash line near the control valves. This affords a means of viewing the backwash discharge water to determine when the filter bed is clean.

Although actual backwash rates cannot be determined by viewing the sight glass, the appearance of filter media in the glass bowl does indicate an excessive backwashing rate.

Where pressure differential indicators or recorders are used to determine backwash rate, manifolds can be installed to use the same instrument to indicate the pressure drop across the filter bed during the filtering cycle. Compound or duplex pressure gages or mercury manometers may be installed to indicate pressure drop across the bed.

When a filter is installed it should be level. After the filter bed has been backwashed and settled for operation the depth of filter media should be uniform. If the filter is not level, however, then the bed will settle unevenly which may result in channeling or disrupting the bed. Filters should have adjustable legs or supports to facilitate leveling and insure a neat appearance in hookup piping.

In recommending a backwash rate and pressure differential indicator manifold for graded bed or permeable plate filters, it should be noted that the size of the manifold should be:

Filter Diameter (ft)	Filter Media	Backwash Line Std. Weight Pipe
4, 5, 6 and 7	Anthrafilt	4-in.
8 and 10	Anthrafilt	6-in.
4, 5 and 6	Sand	4-in.
7 and 8	Sand	6-in.
10	Sand	8-in.

Excessive Backwash Rates

When the backwash velocity is excessive the layers of graded filter media are altered in a graded bed filter. In a disrupted graded bed, the layers of filter media are broken. The smaller size particles penetrate or sift down in the lower layers, while larger particles may be forced to rise to the top.

If the bed becomes disrupted, fine size particles pass through the lower layers of filter media into the injection header. Screens on the injection header trap become clogged or broken, and meters are damaged or become inoperative due to the particles of fine filter media. It is then necessary to remove the filter media, regrade or replace.

In permeable plate filters, only one size of fine filter media is used, therefore the bed does not become disrupted.

Excessive backwash rates will result in loss of filter media, which is literally "washed out" of the filter.

Low Backwash Rates

When the backwash rate is insufficient or too low, the deposits of suspended matter will not be carried out of filter, thus the filter media will not be cleaned.

If the upward flow of water is too low, the graded bed will not be regraded during backwash and will become disrupted as the fine filter media from the top layer penetrate through the bottom support layer.

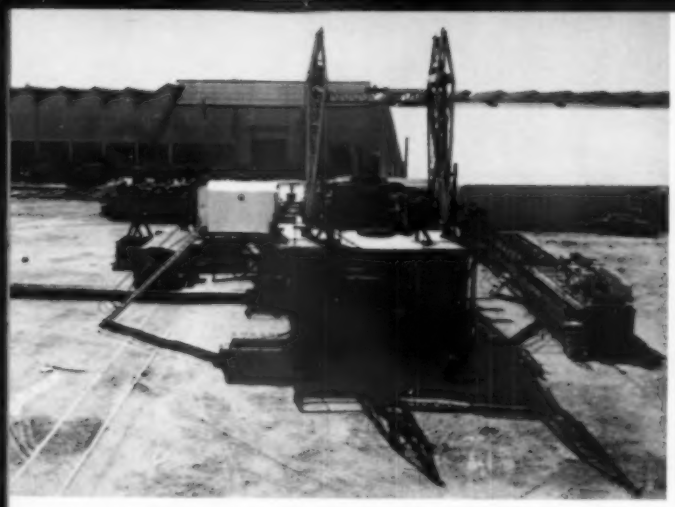
Channeling

Channeling differs from disruption, in that the layers of graded media may remain in a more or less level uniform thickness. Channeling is detrimental to a filter because the velocity through the bed may be increased greatly in certain areas and decreased in others. If channeling is present during backwash the non-uniform velocity may also disrupt a graded bed as will excessive backwash rates. Sudden increase of pressure or velocity surges from transfer pumps may cause channeling or disruption.

Backwash Procedure

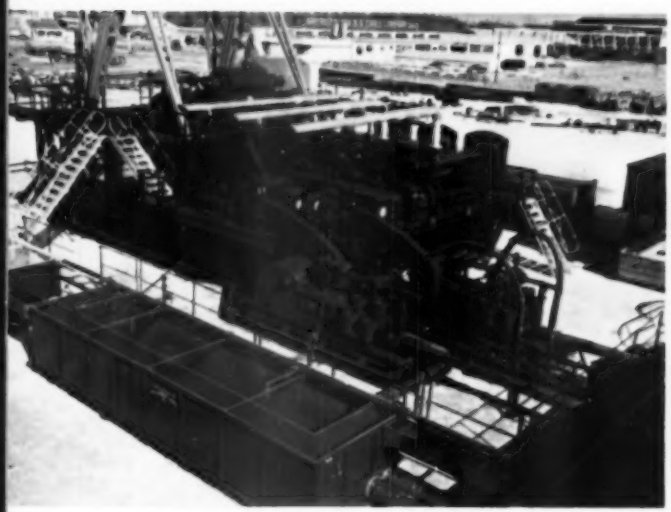
In order to adequately backwash a filter with a minimum loss of filter media, the following procedure has been recommended by some plant operators:

1. Shut off the flow of influent water to the filter to be backwashed.
2. Open backwash inlet valve. The inlet valve must be opened first or there will be a tendency for the incoming water to jet holes in the filter media bed.
3. Open backwash outlet valve slowly. Take at least one minute to open so the pressure will be released slowly, and the filter bed layers kept in place.
4. Maintain proper backwash throughout backwash cycle.
5. Check sight glass in the backwash discharge line for carryover of filter media, and to determine when the bed has been cleaned.



A National 110 rig-up gets underway at our Houston Plant yard. This rig is presently drilling in Africa.

The draw works is now complemented with engines, drive group and slush pumps. This machinery is positioned exactly as it will be used at the well site.



The slush pump manifolding is completed—a "ready to drill" circulatory system from mud tanks to rig floor.

Here's the complete assembly of all machinery and auxiliary equipment, operative and arranged for maximum efficiency.

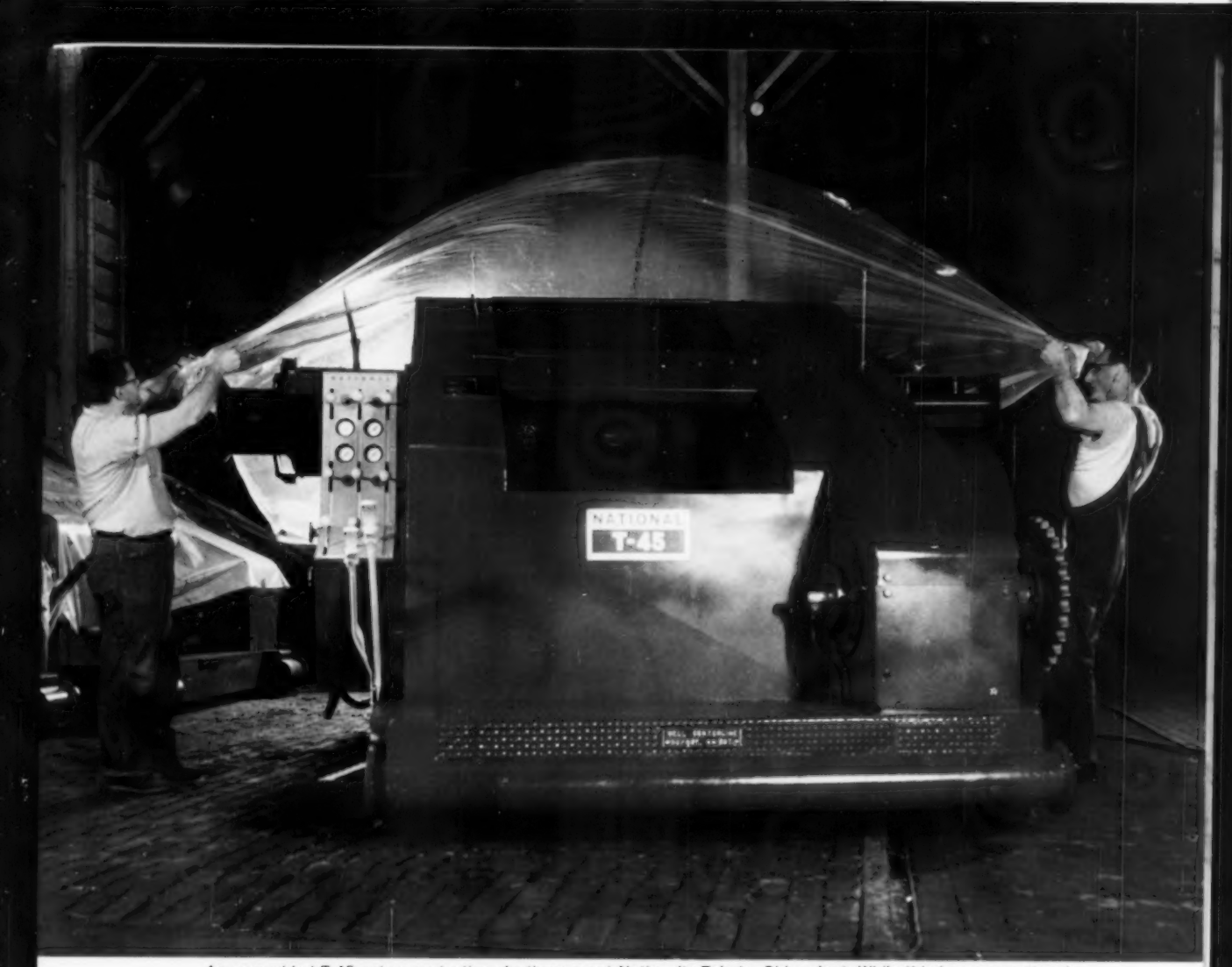
National's rig-up service saves you time and money anywhere in the world!

There's a *sure way* to be *fully* prepared for a new drilling job anywhere in the world—and National Supply's optional rig-up service provides it.

In either of our two special port center rig-up yards or your own equipment yard, we assemble—or direct the assembly of—the complete rig. Everything is positioned exactly as it will be used overseas. Then we test-operate, lubricate and adjust all components. Any problems that may cause initial delays at the well site are promptly solved. If you desire guide photographs similar to those above and paint-coded parts for re-assembly, these are also supplied.

You can see how this rig-up service pays off for operations in remote areas, where services and parts are often days away. But it is also important for rigs closer to home—where even a short delay boosts estimated operating costs.

National has performed this time-and-money saving rig-up service for many years. We have a big list of satisfied customers who report *better rig-up time this way than with previous field assemblies*, and we will be glad to give you more details. Just contact the National representative in your area or our Export Division office in New York City.



An assembled T-45 gets a protective plastic cover at National's Toledo, Ohio, plant. While this is a conventional skid-mounted rig, its compact, streamlined design makes it thoroughly suitable for trailer mounting.

You can trailer-mount this new 550-horsepower National Rig!

The T-45 is designed for medium-deep drilling and the most in mobility!

A 550 input horsepower rig with a normal drilling range from 4500 to 7500 feet—that's National's compact new T-45. Proving once again National's rig design leadership, the T-45 offers you the ultimate in mobility, simplicity and dependability. It's packed with features which not only insure long service life, but also fast, precise operation.

ONE-PIECE MAIN FRAME

The sturdy main frame is of one-piece construction, including an extension skid base for mounting the drive group. You can remove the catheads, air control housing and drive group in a short time—and you have a rig less than 8′ wide, suitable for fast well-to-well moves over any highway.

STREAMLINED PANEL CONTROL

The T-45's streamlined panel control arrangement gives you the maximum in convenience for operating speed and drilling ease. Control valves and all other pneumatic equipment are the highest quality obtainable. Special safety devices are provided in the air system which insures proper regulation and control throughout the draw works. Pressure gages to the major air clutches give a continuous record of draw works performance. Moreover, a generous air supply to the large volume pressure tank in the draw works frame insures peak performance at all times.

BIG MAIN DRUM AND CLUTCHES

You'll get the best spooling performance and wire line life with the T-45's large diameter drum barrel. Either 1" or 1⅛" double crossover counterbalanced wire line grooving is available. There's no need to remove guards or cover plates to anchor the wire line.

The outboard mounted 24" main drum shaft clutch is designed with special emphasis on ample air cooling passageways and long diaphragm life. Lock-up screws are provided for emergency operation.

EFFICIENT DRUM BRAKES

The effective brake band area for the 42" main drum brake is 1600 square inches, and the brake actuating mechanism is of the well-known National Type "K" principle. This system of braking action permits precise feed-off, eliminates brake handle kick-back.

2-SPEED AIR CLUTCH TRANSMISSION

This transmission insures almost instantaneous speed selection. The torque converter drive acts as a cushion and virtually eliminates clutch slippage and heating.

UNLIMITED POWER ARRANGEMENTS

Depending on your space and weight limitations, you can have many variations in engine combinations for the T-45. Its input horsepower rating is 550, and it is basically designed to be driven by one or two engines. Engines can be arranged to offer the following combinations: (1) Two engines which can be mounted on the draw works extension beams and handled as a unit; (2) A two-engine (larger engines) sectional type compound without pump drive; (3) A two-engine sectional compound with provisions for a pump drive, including a supplementary transmission for the draw works; (4) A single engine arrangement without pump drive; (5) Electric motor drive.

MANY OTHER FEATURES

Some other outstanding features of this streamlined new rig include: a "front porch" mounted rotary countershaft; a heavy-duty reverse gear that is standard on all units, and an air-operated catshaft. A sand reel is available as optional equipment.

With all these sound construction features, plus its adaptability for trailer mounting, the new T-45 is a natural for clinching contracts on medium-deep drilling jobs. You can get complete information today from the National representative in your area.

The streamlined control panel on the new T-45 has easy-reach control levers for maximum drilling ease and speed. Special safety devices are provided in the air system which insures proper regulation and control throughout the draw works.

See the next page for the best trailer-mounted rig line available today!

You move, set up and drill fast with National's compact trailer-mounted rigs!

"Minimum downtime—faster operations"—that's what operators say about National trailer mounted rigs and truck-mounted hoists. You will, too, when you use these rugged smaller rigs! You'll get the same quality design features and construction for which the big National Rigs are famous . . . and this quality insures top performance.

Mounted to suit your requirements, these National Rigs are exceptionally fast on rigs-ups and tear downs. Their compact, *packaged* construction permits quick movement—and helps keep between-job downtime to a minimum.

Get all the facts now on portable National Rigs. There are four types—with input horsepower ratings ranging from 120 to 400—enough to meet every rig need in the trailer or truck-mounted horsepower range. Ask the National representative in your area for descriptive bulletins and performance records today.

This complete National T-32 Rig, rated at 400 input horsepower, is shown on location in Mississippi. National Rigs and Hoists utilize torque converter drives for smooth operation and a great variety of running speeds.

THE **NATIONAL SUPPLY** COMPANY
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6. After the backwash water has cleared, close the backwash water outlet valve slowly. Take at least one minute to close. If this valve is closed quickly, the finer filter medium will channel through the supporting layers. The slow closing of this valve will permit the bed to remain graded.
7. Close backwash inlet valve.

After the filter has been backwashed, it is necessary to settle the bed and purge the filter of any unfiltered or contaminated water. The settling allows the filter bed to pack for normal filter operations.

After backwash is completed the following procedure is recommended for settling pressure filters:

1. Open the raw or influent water inlet valve.
2. Open settling valve.
3. Open backwash water outlet valve slowly. Take at least two minutes to open to allow the pressure to be slowly released from the bed, thereby maintaining proper grading. If the valve is opened fast, the filter medium will be forced down through the supporting bed.
4. Settle until waste water is clear (at least five minutes).
5. Close the outlet valve slowly. This maintains proper bed grading.
6. Close settling valve.
7. Slowly open filtered effluent water valve to place filter back in service.

OPERATION OF FILTERS

Use Filtered Water for Backwashing

Dirty backwash water will plug a permeable plate type filter. Use CLEAN FILTERED WATER FOR BACKWASHING. Regardless of the type of filter, dirty backwash water lessens filter efficiency. Some operators in the past have backwashed graded bed filters with unfiltered water. This is a poor policy and should be discouraged.

The amount of backwash water required is a function of the type of filter media or desired backwash rate, the surface area of the filter bed, and the length of backwash.

Filtered wash water is usually supplied by a properly designed backwash pump; however, if sufficient high head of water is available, backwash water may be supplied by gravity. When gas is available, pressure backwash tank may be used, and the expensive backwash pump eliminated.

How to Return Backwash Water to the System

Back water can be returned to the system when required. It is dumped into a surge tank of 50 percent greater volume than the backwash water. The solids settle out in approximately 12 hours and the water is then pumped back into the system at the filter inlet. The closed type system requires the exclusion of air from this operation. This is accomplished by maintaining an oil seal or a gas cap of 4 to 16 oz pressure on the surge tank.

Control Valves

Rising stem type gate valves are recommended for control valves. Since the backwash operation should be started and stopped slowly the slower operating rising stem valve is more suitable than plug valves. Butterfly type valves may be cheaper but should be used with caution. Since they are fast opening or closing, regulation or control of the movement must be encouraged to prevent pressure surges and damage to equipment.

Sample Connections

Sample connections should be installed. Few waterflood or injection systems have sufficient sampling points. Sample connections may be used to determine flow rates, or may permit the operator to draw off samples of influent or raw water and effluent or filtered water.

Pressure Relief

Few installations have sufficient pressure relief devices in water injection systems. Inexperienced operators have closed the wrong valve causing damage or over pressuring of filters and other water treating equipment. Pressure relief valves, pressure safety heads or other relieving devices should be installed on all pressure operated vessels.

Periodic Inspection

Periodic inspection of filters and other water treating equipment are as important as the routine backwashing of filters. The efficiency of the plant can be kept at maximum, and possible trouble or failures may be eliminated while at an early stage and safety of the operators may be improved.

Flow rates. Flow rates of individual filters should be checked periodically to insure maximum filter efficiency. Where several filters are installed, flow rates through each filter should be proportional to their surface area of the filter media.

Pressure drop. Excessive pressure drops would indicate restriction due to dirty filter bed, flow lines with scale or corrosion, plugged wells or other problems. Decrease in pressure drop across the filter bed may indicate a disrupted bed or channeling; therefore, the bed should be regraded or replaced before the injection wells become plugged or other failures occur.

Samples for turbidity. Periodic samples should be taken of the influent water and effluent water. These turbidity readings would indicate the efficiency of the filter. If the efficiency was decreasing, then adjustments should be made in chemical feed, filter bed media, or additional equipment required.

Deposition of iron. Deposition of iron — iron oxide or iron sulfide — decreases the efficiency of the filter. If periodic sampling shows evidence of continued iron deposition, then the filter media can be backwashed every 4 to 8 months with a mild solution of HCl acid (10 percent or less) or any other mild acid.

In permeable plate filters a mild solution of any acid *except* hydrofluoric acid may be used on the permeable plates without any harmful effects. The acidizing treatment will increase the life of the filter media and increase the filtering efficiency. It will also remove any deposition that may have penetrated through the filter media and prevent any possible plugging of the permeable plates.

Deposition of oil. Excessive amounts of oil in the filter should be removed. Quantities of oil will decrease efficiency of filter and increase the pressure drop across the bed. The installation of oil skimmers is recommended to remove the oil.

Chemical analysis. Operators should make periodic chemical analysis of influent water. In one instance the appearance of barium was detected in the influent water. A series of tests showed that only one well was producing water with barium. After reworking the well, the system was restored and injection pressure reduced.

Corrosion. Corrosion is a continuous problem in waterflood projects. Every precaution or protection from corrosion should be encouraged, that is within the economic limit of the company, when selecting waterflood equipment.

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3. Taylor, Sam S. and Christianson, L. F. "Application of Sand Filters to Oil-Field Brine-Disposal System," Bureau of Mines, Report of Investigation 3334, January 1937.
4. Watkins, J. Wade, Willett, F. R., Jr. and Arthur, Charles E., "Conditioning Water for Secondary Recovery in Midcontinent Oil Fields," Bureau of Mines, Report of Investigation 4930, December 1952.
5. Betz, W. H. and Betz, L. D., "Betz Handbook of Industrial Water Conditioning," 1945.

BULK CEMENTING

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by HALLIBURTON

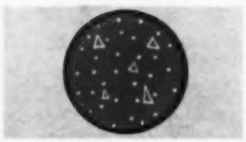
Halliburton Bulk Cementing, the industry's first and finest service of this type, matches the high standards set by all other Halliburton oil well services. From bulk plant to set cement down hole, Halliburton cementing materials, equipment, tools and personnel work together every day to give your well the protection it requires for greatest production and profit.

Specially formulated additives utilized in Halliburton Bulk Cementing help your well meet such challenges as possible sulfate or salt water corrosion, elevated temperatures and pressures, weak formation problems and numerous others. Special cements, too, are available where required. Automatic batch weighing equipment in Halliburton bulk cement plants assure smooth homogeneous mixtures in the correct proportions.

For the best buy in oil well cementing service, specify Halliburton. Most trusted name in oil well cementing.

BETTER CEMENTING BEGINS WITH BETTER BASIC MATERIALS

POZMIX CEMENT



Petroleum technology has yet to discover a material equal to pozzolanic cement for providing lasting oil well protection against the hazards of corrosion, contamination, and ineffective bond between pipe and formation. Two basic types of pozzolanic cement—a blend of Pozmix with portland cement, (Pozmix Cement), and a blend of Pozmix with hydrated lime, (Pozmix 140); are commonly used for oil well cementing.

Pozmix Cement can also be utilized with chemical additives such as retarders, accelerators, and low fluid loss additives, for better control during the cementing operation. Pozmix 140 is designed to obtain long pumpability and strength stability in wells where temperatures range from 140° F to 400° F and higher.

NEW! HALLIBURTON GILSONITE CEMENT

Gilsonite is a new additive used to lighten cement slurry weight down to 10 lb./gal. With a specific gravity almost as light as water (1.07), it adds volume but not weight to the slurry; setting characteristics are not appreciably affected . . . compressive strength is good. Due to its graded particle size, Gilsonite has very low fluid requirements: each 50 lbs. needs but 2 gals. of water. Will not take water from a slurry even under pressure. Unsurpassed for lost circulation or weak formation problems; much less Gilsonite Cement is required.

LATEX CEMENT

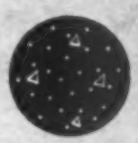
A low fluid loss cement, with superior perforating properties, especially recommended for primary casing cementing..."tail-in" on primary cementing jobs... squeeze cementing... cementing liners.

HI-DENSE

A high specific gravity weight material designed to increase the density of cement slurry for controlling high pressure gas and oil zones. Hi-Dense is ground to a fineness that requires a minimum amount of mixing water. Because of the specific gravity of Hi-Dense, it is possible to weight cement slurries to 20 lbs./gal., yet still maintain adequate pumpability and strength stability at high temperatures.

GEL-CEMENT

Reduced slurry weight, increased slurry volume and lower costs are three benefits resulting from the use of HOWCOGEL, a high yield bentonite additive for cement. When mixed with mud, it provides low fluid loss, reduces filter cake thickness and has high gel-strength properties. Halliburton's Flocele added to Howcogel gives additional sealing strength to these light weight slurries.



HR-4 RETARDER

A small amount of HR-4 added to the mixing water or the dry cement at Halliburton bulk plants results in a composition with a retarded set, permitting placement at high temperatures. It is used with portland, Pozmix Cement or Pozmix 140 Cement in the deepest of wells.

HR-7 DISPERSANT AND RETARDER

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HA-5 ACCELERATOR

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U. S. Recoverable Reserves Set at 43 Billion Barrels

. . . but there's still 208 billion barrels of "unrecoverable" oil

Paul D. Torrey
Austin, Texas

New report 13 billion barrels above API estimate; reflects fluid injection, stripper well importance

1957 WAS THE FIRST YEAR SINCE 1943 that the nation consumed more crude oil than it found. As a matter of fact, of the 23 important oil-producing states, the reserve position was improved in 1957 in only six — Ohio, North Dakota, Nebraska, Louisiana, Utah, and Wyoming.

Such an alarming development in the nation's crude oil reserve position cannot be attributed to any inability on the part of the domestic industry to find and produce oil. It results directly from a substantial decrease in exploration and drilling activity which can be expected to continue as long as operators do not have adequate incentives to maintain normal activity.

New Role for Fluid Injection

Because of the lack of new drilling, greater dependence upon and increased importance is being placed on the part that fluid injection operations will have to play in future oil production.

Already the economically recoverable reserves by known fluid injection methods are greater than the primary reserves in New York, Pennsylvania, West Virginia, Illinois, Michigan, Arkansas, Alabama, and Colorado and they are approximately equivalent in Indiana.

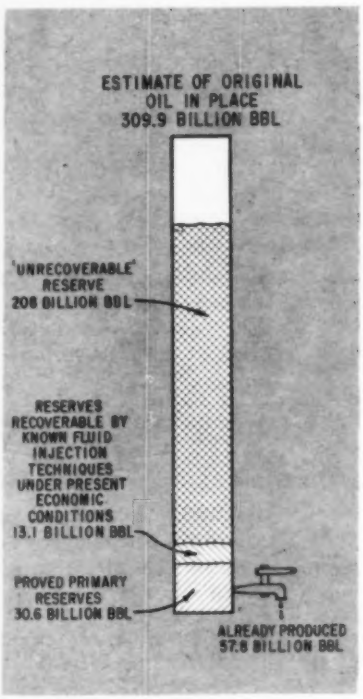
As a result, the Interstate Oil Compact Commission's third annual report on reserves by its Secondary Recovery and Pressure Maintenance Committee reflects a marked increase in the proved recoverable oil reserves of the nation — due to the development and application of fluid injection methods.

These recoverable crude reserves are in the range of some 43 billion bbl of crude oil rather than a little over 30 billion bbl as estimated by others. This represents a very significant increase of 42.7 percent.

The study on which this report is based is the third of its kind that the committee has made. Its previous efforts have received extensive and favorable publicity and its findings have been accepted generally by the federal and state governments and by organizations considering the sufficiency of the nation's mineral resources. Although other studies are made on the amount of oil that will be recovered from the fields of the United States, it is believed that the Compact Committee is the only organization that has estimated the amount of oil that existed originally in their reservoirs and, at the same time, has estimated the amount of additional oil that can be obtained by the application of fluid injection methods.

Statistics presented in Table 1 parallel rather closely those presented two years ago at the midyear meeting of the Compact in Dallas, Texas.[1] In all cases there has been some increase over the figures presented in the previous report. However, it is notable that the increase in the API proved reserves in the years 1956-57 was only about 18 percent of the increase that took place in the preceding biennium. It is significant that all of the minor increase in the API proved reserves took place in 1956 and that, actually, there was a decrease in the proved reserves of crude oil in the United States during 1957 in amount of some 134 million bbl.

As was the case in the previous report, the estimated primary reserves are very close to the estimation by the API Committee of the proved reserves. However, if the Compact Committee's primary reserves are added to its econ-


ESTIMATE OF ORIGINAL OIL IN PLACE 309.9 BILLION BBL
'UNRECOVERABLE' RESERVE 208 BILLION BBL
RESERVES RECOVERABLE BY KNOWN FLUID INJECTION TECHNIQUES UNDER PRESENT ECONOMIC CONDITIONS 13.1 BILLION BBL
PROVED PRIMARY RESERVES 30.6 BILLION BBL
ALREADY PRODUCED 57.6 BILLION BBL

208 billion barrels of oil — a recovery challenge for the industry — or might it be just as worthless as so much bs&w?

Adapted from the report of the Secondary Recovery and Pressure Maintenance Committee, Interstate Oil Compact Commission presented on June 23, 1958, at the Mid-Year meeting of the IOCC in Salt Lake City, Utah.

[1] "Evaluation of United States Oil Resources as of January 1, 1956," The Oil and Gas Compact Bulletin, Volume XV, No. 1, pp. 19-21, June 1956.

omically recoverable fluid injection reserves, the sum is considerably greater than the API proved reserves. The fact that the findings of the two committees are not in agreement is not surprising, and is no cause for concern. The Compact Committee takes the optimistic view that the results that have been obtained in literally hundreds of fluid injection operations, in almost every oil-producing state of the nation and for which there is now a historical record in some fields of 35 years of continuous operation, are sufficiently dependable to be used as a criterion for the estimation of the possible additional recovery that can be obtained from the oil fields of the United States.

It will be evident that certain of the State Committees and Geological Surveys believe that their respective primary reserves are higher than API estimations. This is a matter of opinion, and certainly need not be cause for contention for it is well known that the API Reserves Committee periodically has revised and increased its estimations of proved reserves as new fields have been discovered, as the area of known fields has been expanded, or as deeper reservoirs have been found in older fields.

As new oil fields are found the original oil content of the known reservoirs is increased. The Compact Committee estimates that this original oil content has amounted to the impressive figure of 309.9 billion bbl.

'Secondary reserves' already are greater than primary reserves in eight states

Recovery

If the combined primary and fluid injection reserves are added to the past production of the oil fields of the United States, it will be seen that the known fields of the nation probably will produce eventually about 101.5 billion bbl of oil, which amounts to 32.8 percent of the original oil in place. Although this percentage of recovery is much less than that obtained by certain other mineral industries, it represents a great improvement over the recovery that was obtained from oil fields only a few decades ago.

Such improvement is due in large measure to the adoption of conservation practices by most of the states and to the invention of new production techniques. Thus, it can be foreseen that a greater recovery of the nation's oil resources will be obtained in the future than has been the case in the past.

Nevertheless, the some 208 billion bbl that will not be recovered under existing conditions presents a challenging problem from the standpoint of the tremendous energy potential involved, for the security of the nation, and because the production of oil contributes so much to the maintenance of government and to the comfort and welfare of the people.

There are well known irreducible minimums beyond which oil cannot be extracted from its containing reservoirs by water drive, similar to the fact that certain amounts of coal cannot be removed from underground mines. Thus, it would be a reasonable guess that there is no way to recover some 62 billion bbl of the original content of the nation's reservoirs by artificial water injection. Also, the recovery of large quantities of oil that remain may not be feasible for geologic reasons and certainly will be dependent on economic conditions in future years. As the committee has shown in Table 1, it is already known that almost three times as much oil is susceptible to recovery by fluid injection techniques than can be extracted profitably by these methods under present conditions. Although the recovery of much of this oil by these methods is problematical at this

TABLE 1. Evaluation of United States Oil Resources as of January 1, 1958.
All figures in millions of barrels of 42 U. S. gallons.

State	Estimation of Original Oil Content of Reservoirs	Total Oil Production to 1/1/58	1957 Oil Production API Figures	API Proved Reserves from Volume 12 (A)	Percent of Proved Reserves Produced in 1957 (B)	Proved Primary Reserves as of 1/1/58	Reserves Recoverable by known Fluid Injection Techniques	Reserves Recoverable by Fluid Injection Under Economic Conditions Existing at 1/1/58
New York	743	202	3	38	7.1	0	63	52
Pennsylvania	3,831	1,203	8	126	6.5	29	771	126
West Virginia	2,585	458	2	53	4.2	49	594	60
Kentucky	1,450	352	17	138	12.5	140	450	65
Ohio	4,500	649	6	68	8.1	65	185	7
Indiana	3,000	281	12	67	17.7	66	265	65
Illinois	7,211	1,996	76	655	11.6	356	3,250	1,200
Michigan	1,423	406	10	49	20.8	51	290	95
North Dakota	2,699	50	13	258	5.0	649	757	110
Nebraska	1,030	75	20	63	31.1	80	80	50
Kansas	14,700	2,959	124	948	13.0	850	325	100
Oklahoma	47,035	7,627	211	1,942	10.9	1,510	1,416	566
Arkansas	4,147	996	30	305	9.7	149	1,270	1,100
Alabama	358	18	6	34	18.7	58	118	98
Mississippi	3,107	546	37	360	10.3	407	1,032	86
Louisiana	22,423	4,333	298	3,858(C)	7.7	4,051	5,070	2,282
Texas	105,357	21,058	1,057	14,555(C)	7.2	15,201	10,236	4,856
New Mexico	8,000	1,178	92	832	11.1	1,094	2,288	500
Colorado	3,106	456	55	310	17.7	282	887	610
Wyoming	10,511	1,542	110	1,420	7.7	1,234	1,133	403
Montana	2,686	276	27	320	8.4	346	155	62
Utah	380	18	5	140	3.3	140	76(D)	28(D)
California	59,560	11,130	339	3,760(C)	9.0	3,760(C)	3,770	573
Other States(E)	65	9	1	4	13.2	4	2	1
Total	309,907	57,818	2,559	30,300	8.4	30,580	34,483	13,095
Change from 1/1/56	+21,384	+5,131	+140(F)	+288		+910	+1,653	+1,116

(A) American Petroleum Institute and American Gas Association, "Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, December 31, 1957, Volume 12."
(B) Calculated from actual production figures rather than abbreviated production figures.
(C) Includes offshore reserves.
(D) Estimated by Paul D. Torrey; subject to future revision and correction.
(E) Includes Arizona, Florida, Missouri, Nevada, South Dakota, Tennessee, Virginia, and Washington.
(F) Change from 1955 to 1957 production.

Revised June 8, 1958

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time, knowledge of its existence is important.

Since the committee presented its report to the Compact at the Dallas meeting in 1956, much attention has been given to the recovery of oil by condensing gas drive and other forms of high-pressure gas injection, and by thermal drive. Under certain reservoir conditions it is believed that the application of these methods will result in the recovery of a substantial part of the total oil content, particularly in fields of fairly recent discovery. Thus, there are promising prospects that in future years much greater recovery efficiency will be obtained than has been the case in the past. However, similar to the conditions that control the development of new primary reserves, there must be adequate incentive provided to encourage the widespread utilization of these marvelous new inventions and processes.

Strippers

Although figures for 1957 are not yet available, it is a reasonable supposition that about 3.9 billion bbl or 30 percent of the economically recoverable fluid injection reserves exist in stripper well fields; that is, in fields where the cost of production equals or is approaching the value of the oil produced.

Recent studies have shown that almost three-quarters of all of the oil wells in the United States are in the stripper or marginal classification.

The oil reserves in the stripper fields are particularly precious to the United States, because many of them were discovered several decades ago when the cost of finding, developing, and operating oil fields was much less than it is at the present time. If these old wells should be abandoned for any reason, such as a lack of market for the crude oil they produce, manifestly, it might be unprofitable to drill new wells and install new equipment, at a cost that might be four times the original development cost, even though a proved secondary reserve of large size is known to be present.

Conservation

In Table 2 the manner in which respective states utilized their oil resources in 1957 is shown. This table is not presented for the purpose of criticism of any particular state's policy. It is, however, revealing in that it shows that the life of the oil industry is certainly going to be extended in states where maximum recovery by fluid injection methods has been encouraged by wise conservation laws and by the initiative of the industry. Of course, much more oil is going to be found in the future in most of the states, but this oil is going to be progressively more difficult to find and certainly more expensive to find. As a result, the United States in the future is going to have to place increasing reliance on oil that has already been found, on imports of hydrocarbon liquids, and on other sources of energy.

Three-fourths of the wells in the U. S. are in the stripper classification

The phenomenal growth in the production of oil from fluid injection projects in post World War II years is the best evidence that can be presented on the significance of these operations. In fact, outside the actual discovery of oil reserves, the development and application of fluid injection techniques certainly ranks as the most important single factor in the maintenance of the oil industry in many of the states.

Credits

This report represents a continuation of studies that have been made periodically by the Secondary Recovery and Pressure Maintenance Committee to determine the amount of oil that has been discovered in the fields of the United States and the amount of oil that will be recovered from them. The report has been made in accordance with instructions received from the chairman and the Executive Committee of the Interstate Oil Compact Commission and conforms to the action of the Secondary Recovery and Pressure Maintenance Committee at its meeting in Miami Beach, Florida, December 6, 1956, which was confirmed subsequently by letter ballot, as reported to the committee on February 18, 1957.

It should be understood that most of the contributors to the study have been selected by the governors of the respective states as being the leading authorities in this highly specialized field. Thus, the information they have developed can be accepted as the most reliable that can be obtained.

It will be noted that Table 1 has been expanded to include the states of Nebraska, Alabama, and Utah in which significant discoveries of oil have been made in recent years, and which the committee considers to be of sufficient importance to justify individual treatment. Attention is called to the fact that some of the statistics on Utah are subject to later correction and revision, as could be expected in a state where the discovery of important oil fields has been of such recent date. It is a well known fact that all figures relating to oil reserves are changed from time to time as new fields are discovered or as more effective methods of oil recovery are developed, so Utah is no exception from the historical experience of other states. ★ ★ ★

TABLE 2. Utilization of Crude Oil Reserves in the United States.
All figures in millions of barrels of 42 U. S. gallons.

State	Combined Primary and Fluid Injection Reserves	1957 Production	Percent of Reserve Produced in 1957 (A)
New York	52	3	5.1
Pennsylvania	155	8	5.3
West Virginia	109	2	2.0
Kentucky	205	17	8.4
Ohio	72	6	7.7
Indiana	131	12	9.0
Illinois	1,556	76	4.9
Michigan	146	10	7.0
North Dakota	759	13	1.7
Nebraska	130	20	15.1
Kansas	950	124	13.0
Oklahoma	2,076	211	10.5
Arkansas	1,249	30	2.4
Alabama	156	6	4.1
Mississippi	493	37	7.5
Louisiana	6,333	298	4.7
Texas	20,066	1,057	5.3
New Mexico	1,594	92	5.8
Colorado	892	55	6.2
Wyoming	1,637	110	6.7
Montana	408	27	6.6
Utah	168	5	2.7
California	4,333	339	7.8
Other States	5	1	13.0
Total	43,607	2,559	5.9

(A) Calculated from actual production figures rather than abbreviated production figures.

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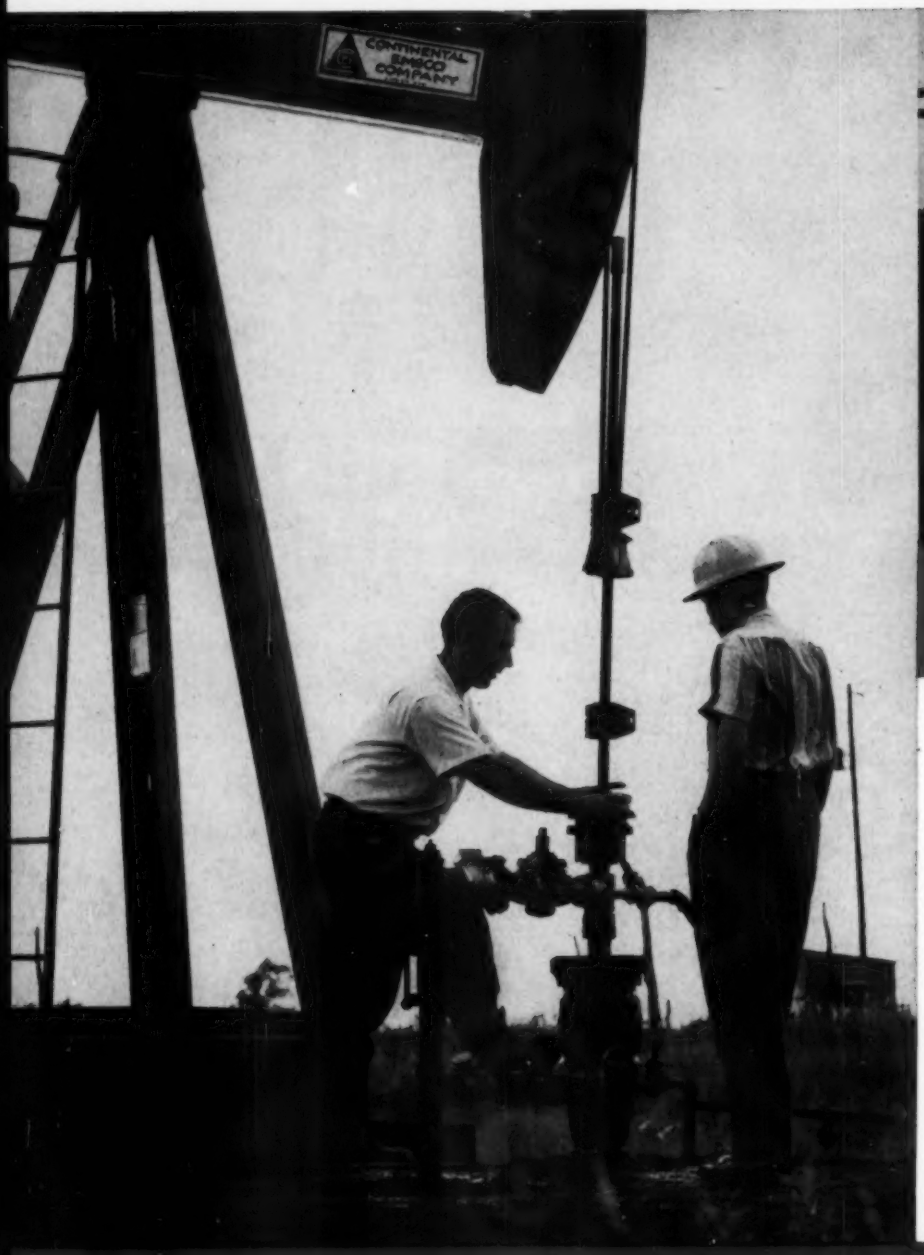

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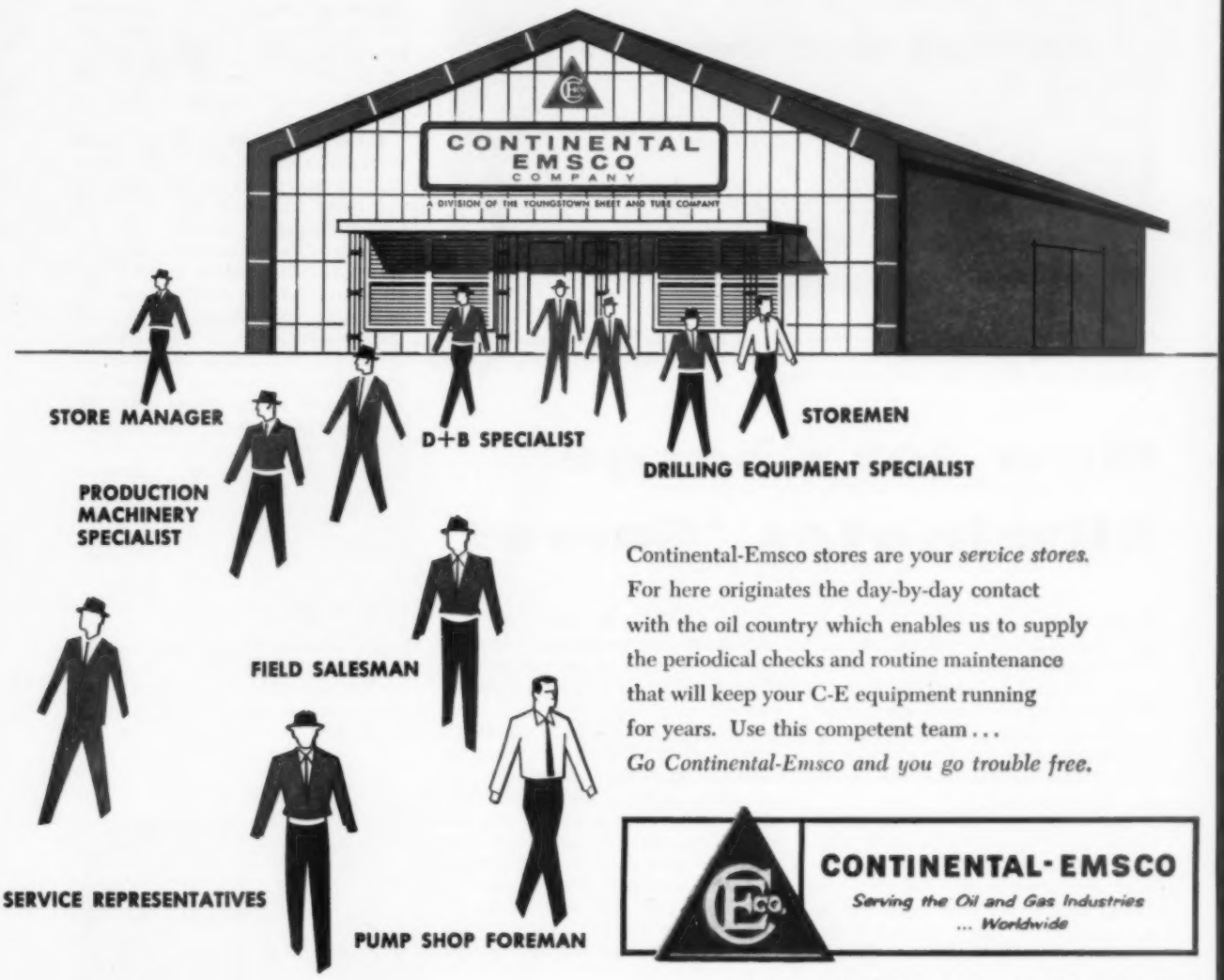

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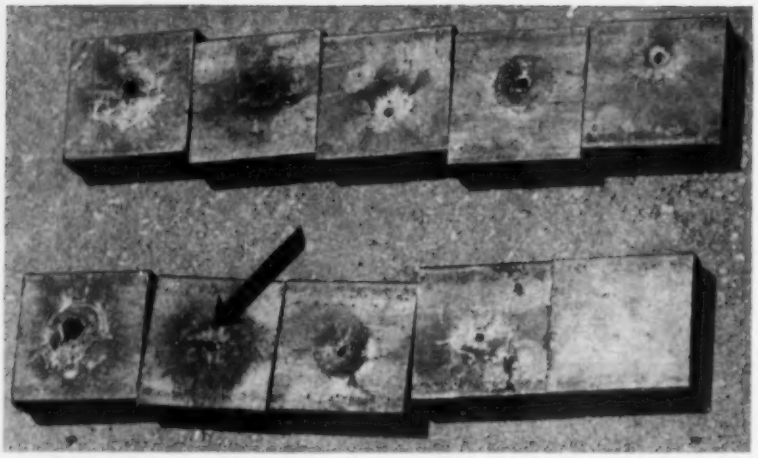

FIG. 1. Targets of 1-in. mild steel blocks demonstrate carrot-free perforation made by Jet Research's Super Dyna-Jet charge (upper target) and carrot-plugged perforation shot with conventional jet charge (second block, lower target).

New Jet Charge Eliminates 'Carrot'

WITH THE DEVELOPMENT of its new Super Dyna-Jet shaped charge, Jet Research Center, Inc., has created a jet perforating charge designed to eliminate completely the formation of the carrot-shaped slug often formed and deposited in the flow channel of jet-perforated formations. Heart of the improved charge is a new liner.

In its preliminary studies to design a carrot-free charge, Jet Research went back to the basic theories of jet perforation. A shaped charge consists of a charge of high explosive contained in a metal case with the front part of the charge molded in the shape of a depressed cone and supported by a thin metal liner. Detonation of the charge begins at the back of the explosive and travels in high order detonation waves which impinge upon the back of the metal liner. The tremendous force of the detonation waves causes particles of the metal liner to spall off and converge at the axis of the cone to form the jet stream. That portion of the metal liner which does not form part of the jet stream collapses into a mass which often follows the jet stream into the perforation. This mass is the troublesome carrot.

Attempts have been made to eliminate the plugging effects of carrots, either by deflecting the carrot from the perforation or by reducing the size of the carrot. However, Jet Research engineers and technicians set out to eliminate entirely the formation of the carrot. The result of this project is a new material and technique employed in the fabrication of the conical liner which supplies the material for the jet stream.

Basically, the new liner consists of very small particles of a copper alloy supported in a matrix of weaker copper alloy. In firing, the charge blasts part of the liner into the jet stream, just as with the conventional solid copper liner. But the remainder of the Super Dyna-Jet liner does not collapse and enter the perforation as a carrot. Instead, due to the low-melting copper alloy matrix, it disintegrates without forming the slug.

Comparative tests of the new shaped charge include firing into blocks of steel to verify the carrot-free perforation. As shown in Fig. 1, the Super Dyna-Jet and a conventional charge are fired into blocks of 1-in. mild steel with a clearance, or "stand-off," of ½ in. in air. The hole formed by the conventional jet charge (lower target) is plugged by the slug made up of the "waste" from the liner. The new charge, however, makes a carrot-free perforation in the steel blocks (upper target).

The hole-making ability of the Super Dyna-Jet compares favorably with that of Jet Research's present Dyna-Jet and results in less burr as well as no carrot. Fig. 2 shows typical surface tests of the two charges fired into targets of 16 lb-per-gal neat cement with 1 percent bentonite, faced with sections of 5½-in. N-80, 17-lb-per-ft casing and aged 16 days. In this illustration, target No. 1 was shot with a conventional charge and resulted in a penetration of approximately 10½ in. In target No. 2, the Super Dyna-Jet perforated to a depth of slightly more than 12 in. These shots were made with charges mounted in a standard 4-in. jet perforating gun.

Perforation made with the Super Dyna-Jet results in only a small burr. Average burr height in a series of tests was 0.041 in., much less than from typical charges now in use.

The new charge has the same external physical dimensions as the Dyna-Jet charge and will require no change in loading technique or loading tools, and the same alignment parts are used as before. This charge has been designed basically for 4-in. carriers, but is adaptable to the 3⅜-in. and 5-in. carriers as well. Only parts necessary to adapt the charge to these two carriers are different length alignment sleeves to compensate for the difference in stand-off in the various carriers and a larger ID alignment washer to accommodate the larger OD sleeve used in 5-in. carriers. Standard seals and screw port plugs are used with the charge.

Jet Research Center, Inc. functions as a service organization to all licensed jet perforating service companies to whom the new Super Dyna-Jet will be available. * * *

FIG. 2. Targets of 16 lb-per-gal neat cement with 1 percent bentonite aged 16 days and faced with 5½-in. N-80 casing section show relative penetration depths of conventional jet charge (1) and Super Dyna-Jet charge (2).

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2	How many years have these units been in operation in the field?	5½	1½	½**
3	How many different models of units are advertised as being available?	27	2	1**
4	Is power pump required for the operation of the unit?	NO	YES	YES
5	Is the unit complete with inlet separator as part of the "package"?	YES	NO	NO
6	Are any units operating on offshore platforms?	YES	NO	NO
7	Are any units operating in sub-zero climates?	YES	NO	NO
8	Are any units operating on hot compressor discharge gas?	YES	NO	NO
9	Are any units processing full wellstreams, serving as separation, dehydration, AND hydrocarbon recovery equipment?	YES	NO	NO
10	Are any units "riding" gas pipelines, serving as dehydration and hydrocarbon recovery equipment?	YES	YES	YES**

*Conventional Unit, converted to short cycle for experimentation
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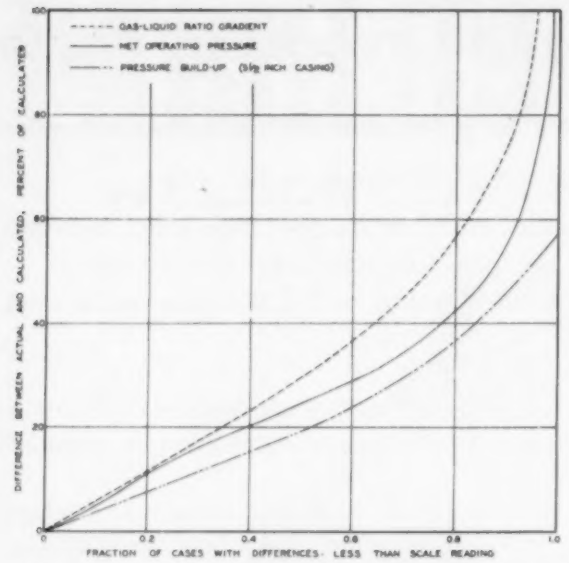
GAS-LIQUID RATIO GRADIENT
NET OPERATING PRESSURE
PRESSURE BUILD-UP (3½ INCH CASING)
DIFFERENCE BETWEEN ACTUAL AND CALCULATED, PERCENT OF CALCULATED
FRACTION OF CASES WITH DIFFERENCES LESS THAN SCALE READING

FIG. 5. **Accuracy** that may be expected from the use of least squares equations for gas and pressure (2-in. plunger).

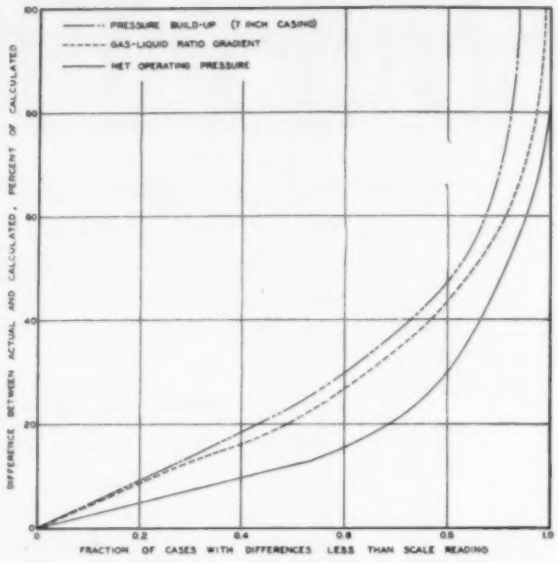
PRESSURE BUILD-UP (7 INCH CASING)
GAS-LIQUID RATIO GRADIENT
NET OPERATING PRESSURE
DIFFERENCE BETWEEN ACTUAL AND CALCULATED, PERCENT OF CALCULATED
FRACTION OF CASES WITH DIFFERENCES LESS THAN SCALE READING

FIG. 6. **Accuracy** that may be expected from the use of the least squares equations (2½-in. plunger).

Short-Cut Design Calculations and Field Applications of . . .

The Plunger Lift Method of Oil Production

Two types of wells illustrate nomograph use

Carrol M. Beeson
Petroleum Engineering Deprtment, The University of Southern California, Los Angeles, California

Donald G. Knox and John H. Stoddard
The National Supply Company, Los Angeles, California

THE NOMOGRAPH instructions given earlier have been applied to examples illustrating two different types of wells. For the first example well, the probable gas-liquid ratio required at maximum production rate is considerably higher than the well's formation gas-liquid ratio. For the second example well, it is considerably lower, so the situation is reversed.

EXAMPLE WELLS

The first example well is illustrated on the accompanying nomograph for the 2-in. plunger and the second is on the accompanying nomograph for the 2½-in. plunger.

PART 4 EXAMPLES DEMONSTRATE USE OF NOMOGRAPHS

Data		
Plunger Size, In.	2	2½
Tubing Size, OD, In.	2⅜	2⅞
Casing Size, OD, In.	5½	7
Tubing Depth, D, Ft	6600	9200
Anticipated Minimum Tubing Pressure, P_t, psi	60	100
Productivity Index, J, (B/D)/psi	0.12	0.08
Static Bottom Hole Pressure, P_{ws}, psi	800	2100
Gas-Liquid Ratio, G/L, CF/B	3035	6900
Gas-Liquid Ratio Gradient, G/L / D/1000, CF/B / Ft/1000	460	750
Solution By Nomograph		
Step I		
P_{ws}, psi	800	2100
$P_t\,(0.990)\,(1+0.027\,\frac{D}{1000})^{min}$, psi	70	—
$P_t\,(0.974)\,(1+0.027\,\frac{D}{1000})^{min}$, psi	—	122
$P_{ws}-P_t\,(0.990)\,(1+0.027\,\frac{D}{1000})^{min}$, psi	730	—
$P_{ws}-P_t\,(0.974)\,(1+0.027\,\frac{D}{1000})^{min}$, psi	—	1978

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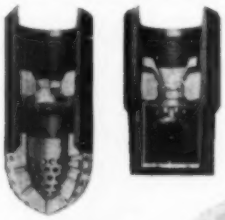

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Step II		
Intercept 1, B/Cy	2.66	14.08
Step III		
Intercept 2, B/D	72.5	146
Step IV		
Maximum Production Rate, B/D	57.0	121.5
Size Load at Maximum Production Rate, B/Cy	0.58	2.36
Cycle Frequency, Cy/D	98	51.5
Cycle Time, Min/Cy	15	28
Required Gas-Liquid Ratio Gradient, CF/B / Ft/1000	880	454
Required Gas-Liquid Ratio, CF/B	5808	4177
Required Daily Gas Volume, Mcf/D	331	508
Net Operating Pressure, psi	236	394
Minimum Tubing Pressure, psi	60	100
Maximum Casing Pressure, psi	296	494
Step V-a		
Required Gas-Liquid Ratio Gradient, CF/B / Ft/1000	880	454
Formation Gas-Liquid Ratio Gradient, CF/B / Ft/1000	460	750
Difference Between Required and Formation Gas-Liquid Ratio Gradient, CF/B / Ft/1000	420	−296
First Alternative		
Required Volume of outside gas to make up deficiency and attain Maximum Production Rate, Mcf/D	158	—
Second Alternative		
Size Load which can be produced on Formation Gas alone, B/Cy	1.51	—
Production Rate at above Size Load, B/D	31.7	—
Cycle Frequency, Cy/D	21	—
Cycle Time, Min/Cy	69	—
Net Operating Pressure, psi	420	—
Minimum Tubing Pressure, psi	60	—
Maximum Casing Pressure, psi	480	—
Step V-b		
First Alternative		
Volume of excess gas to be removed, Mcf/D	—	331
Second Alternative		
1. Size Load at given value of Minimum Tubing Pressure and Formation Gas-Liquid Ratio Gradient, for locating Intersection of Operating Lines, B/Cy	—	1.22
2. Intercept 2-A, B/D	—	247
3. Production Rate, B/D	—	98
Size Load at above Production Rate, B/Cy	—	1.6
Cycle Frequency, Cy/D	—	61
Cycle Time, Min/Cy	—	24
Minimum Tubing Pressure, psi	—	421
Net Operating Pressure, psi	—	314
Maximum Casing Pressure, psi	—	735

ACCURACY EXPECTED FROM RESULTS

As stated earlier, the equations for gas and pressure were derived from correlations of field data by the method of least squares. This method yields expressions that represent actual field experience. Some of the data may have been submitted for plungers that were not being operated under conditions most suitable for the well. Nevertheless, the net operating pressure, gas-liquid ratio and pressure build up that were being used undoubtedly were the values required for the chosen set of operating conditions.

In operating a plunger, it has always been possible to control the pressure in the casing and the volume of any outside gas that was being circulated. Before the equations and nomographs were available, however, it was not easy to choose the operating conditions most suitable for a well. The above factors are interdependent with size load and minimum tubing pressure. Consequently, the values chosen for maximum casing pressure and gas-liquid ratio will influence size load and minimum tubing pressure.

It follows, therefore, that the well data submitted for various sets of operating conditions were suitable for deriving the equations relating these interdependent variables. The method of least squares permitted determination of these relations in terms of probable or average values, thus minimizing the effects of errors and other variations. In addition, use of this method in deriving the relations had the usual advantage inherent in a method based on experience.

Another major advantage in such correlation equations is due to the opportunity of choosing safety factors that correspond to practically any degree of certainty desired in results obtained through use of the equations. This is amplified by the discussion of accuracy in the following paragraphs:

The accuracy to be expected from use of the equations for gas and pressure is illustrated by Fig. 5 and 6. In obtaining the curves for the figures, the data for a well was substituted into the appropriate equation and a factor, such as net operating pressure, was calculated. This was subtracted from the actual reported data and the difference was expressed as percent of the calculated value. These percentage differences were arranged in order of increasing magnitude. The values at various fractions of the total number of cases were then plotted and a smooth curve was drawn among the points. Any point on such a curve indicates that the fraction of cases directly below the point had percentage differences equal to or less than the value horizontally opposite the point.

As an example of use of the curves, it may be noted in Fig. 5 that the actual net operating pressure for 0.5 of the cases fell within ± 24 percent and for 0.9 of the cases within ± 55 percent of the calculated values. These would be the variations which should include the actual net operating pressure for one out of two new cases, and nine out of ten new cases, for which the appropriate equation is applied. For the 2½-in. plunger, the corresponding values are ±12 and ± 47 percent. These conclusions stem from the fact that 0.5 and 0.9 of the cases studied fell within these variations and the same should hold for new cases.

A percentage variation (or safety factor) which is allowed in predicting net operating pressure usually should lie somewhere between the above pairs of values, depending on the degree of certainty desired. For practical purposes, the same variation may be allowed in predicting production rate.

The last statement does not concern any inaccuracies involved in the productivity index equation. This relation with its advantages and disadvantages, has been the subject of many articles in the past and doubtless will be the subject of many more in the future. The equation has become an important tool in predicting production rates, and its validity is beyond the scope of the present series of articles.

As stated in the nomograph instructions given earlier, an average value for the productivity index should be used, if it is known to vary with production rate. Also it should be emphasized that unless both the static bottom hole pressure and the productivity index have been determined quite recently, one of these should be computed. For example, if the static pressure is the one more recently determined, it should be substituted into the productivity index equation, along with the production rate and the flowing bottom hole pressure which has been measured or calculated from the well's operating conditions. This permits computation of the productivity index for use with the nomographs.

The accuracy to be expected from use of the equations for gas-liquid ratio gradient may also be read from the curves of Fig. 5 and 6. For the 2-in. plunger, 0.5 and 0.9 of the cases were within ± 30 and ± 73 percent. For the 2½-in. plunger, 0.5 and 0.9 of the cases were within ± 21 and ± 57 percent.

A similar statistical analysis of accuracy can not be made for the maximum production rate equations. This is not, however, a serious disadvantage. These equations are used in the nomographs only for fixing an upper limit to the gross production rate expected from the free piston system. Furthermore, operating conditions may be set so that the maximum production rates given by the equations are actually attained.

TO BE CONTINUED

Part 5, "Plunger Lift Applications," which will conclude this series, will appear next month.

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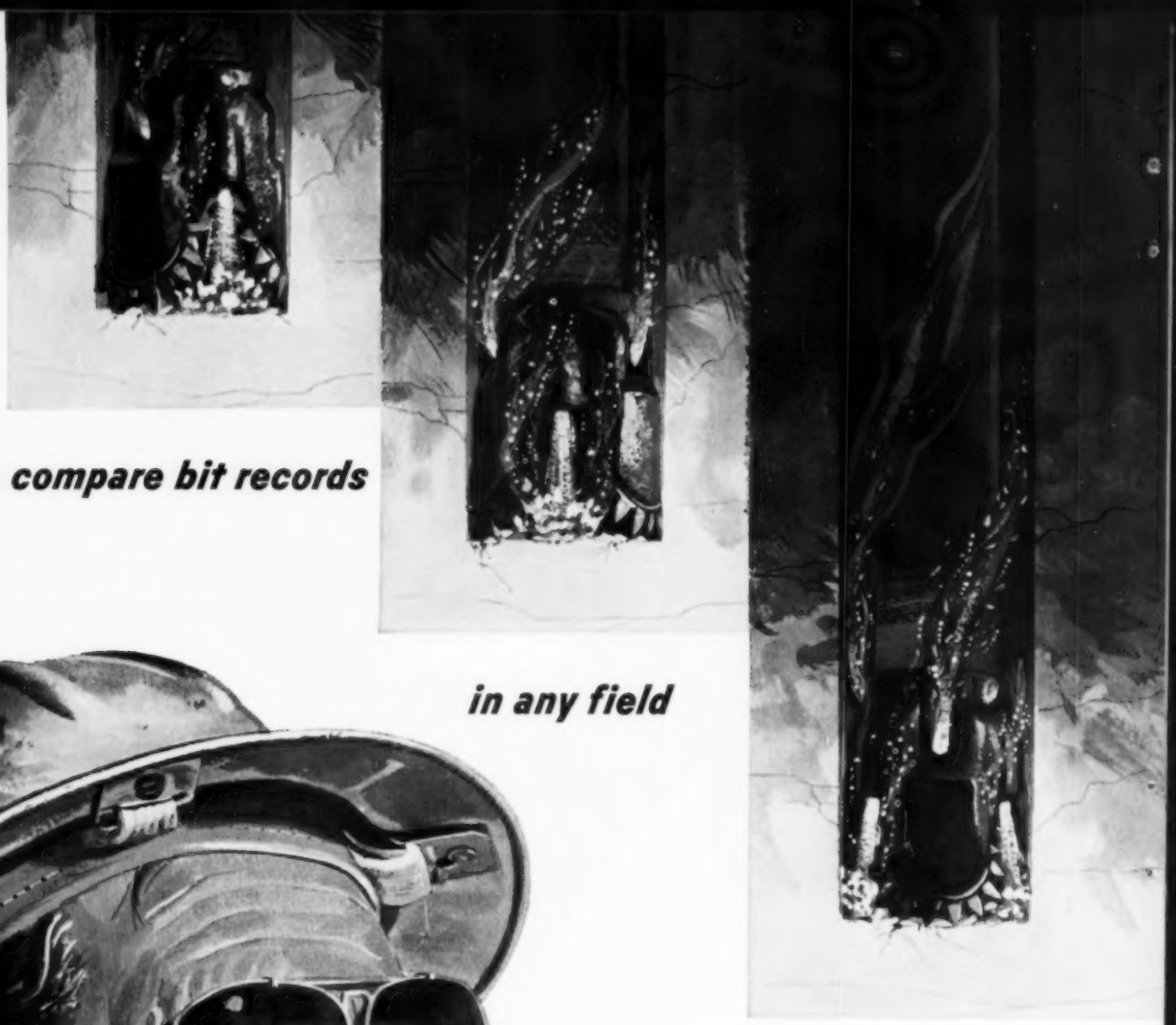

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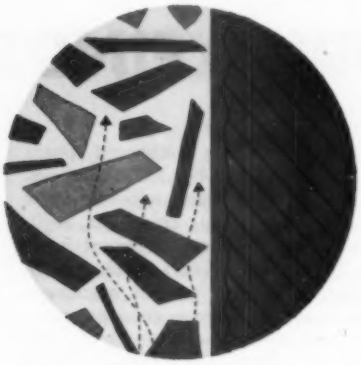

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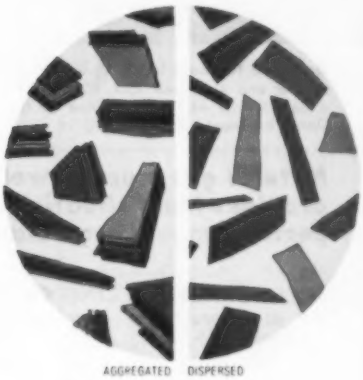

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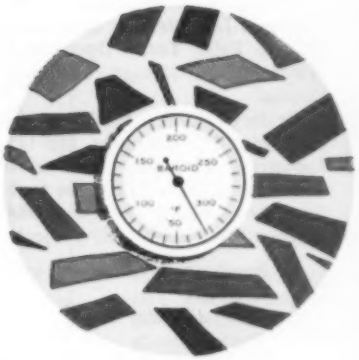

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Going in the hole is a 17½-in. bit, a four-blade reamer and a 10¼-in. OD, 80 stage turbodrill at a gas storage well being drilled on the Herscher Dome by Moran Brothers' Rig 14.

TURBODRILL FINDS

Natural gas storage well project at Herscher, Illinois, provides ideal situation for optimum turbodrilling performance: Large diameter hole and hard formations

A CONTRACT CALLING for drilling of several large diameter holes through several hard abrasive formations in central Illinois has proved a successful development ground for the turbodrill. The wells are being used for injection of gas into the Herscher Dome where it is being stored for winter use in Chicago area markets.

Drilling is in the hands of Moran Brothers, Inc., drilling contractors of Wichita Falls, Texas. Operator is the Natural Gas Storage Company of Illinois.

Drilling engineers for Moran Brothers, Natural Gas Storage, and Dresser Industries, developers of the turbodrill in the U. S., have found the tool particularly adaptable to these conditions, all found in the Herscher project:

1. Hard, abrasive and broken formations
2. Large diameter hole
3. Shallow depth

The shallow depth of the gas storage wells (1440 ft of turbodrilled section) has in the past proved difficult to drill because of the presence of the hard section, since it was impossible to apply sufficient weight on bit for rapid penetration. Large diameter of the hole was another factor. The wells required 30 ft of 20-in. conductor pipe at the top of the hole, followed by a 750 ft string of 13⅜-in. casing cemented in 17½-in. hole. Then a 12¼-in. hole was drilled to approximately 1440 ft and cased with 9⅝-in. pipe. It was to this point the wells were turbodrilled. From this point to total depth of approximately 2550 ft and 8¾-in. hole was drilled with jet bits and 7-in. casing run.

Herscher Stratigraphy

Approximately 1450 ft of clastic and carbonate sediments are being drilled in the Herscher gas storage field, located in Kankakee County. The formations encountered are of Cambrian and Ordovician age and consist, primarily, of shales, sandstones, and dolomites.

First 150 ft, more or less, consists of firm, calcareous, gray shales of the Maquoketa formation. Unconformably underlying the Maquoketa shales are approximately 385 ft of Galena-Platteville dolomites. This is entirely a carbonate sequence and is composed of dense to finely crystalline, relatively massive dolomites with a 50-ft limestone section encountered at a depth of approximately 400 ft.

The St. Peter sandstone unconformably underlies the Galena-Patteville sequence and maintains a rather remarkably uniform thickness of 200 ft. The formation is encountered between 525 and 550 ft in the subsurface. The upper 130 ft is essentially a fine to very fine grained sand that grades downward into well-sorted, medium-grained unconsolidated sandstone in the lower 70 ft.

Unconformably underlying the St. Peter sandstone is the Prairie du Chien group, about 350 ft thick. In descending order are the Shakopee, New Richmond, and Oneota formations. The Shakopee and New Richmond consist of 200 ft of thin-bedded sandstones, cherts, and compact dolomites. The Oneota is a coarsely crystalline, argillaceous dolomite with frequent interbedded cherts and chert nodules. A 10-ft, fine to medium grained, calcareous cemented sandstone is encountered at the base of the Oneota and marks the contact between the Ordovician and Cambrian systems in the area. The well is used with 13⅜ surface string above 20 ft into the Shakopee.

Underlying the Oneota sandstone are compact dolomites of the Trempealeau formation. The sequence is approximately 300 ft in thickness. The lower 200 ft consists of vugular and fractured dolomite that has been a particularly troublesome lost circulation zone.

The Franconia formation conformably underlies the Trempealeau dolomites and consists of an upper 100 ft member of very five grained, dolomitic cemented, glauconitic sandstone. Wells are turbodrilled into the Franconia.

Present gas storage reservoir is the Galesville sandstone, encountered at an average depth of 1750 ft and 340 ft below the top of the Franconia formation. Wells are being bottomed in the Mt. Simon, newest gas reservoir now in early development.

Drilling Program

Turbodrills used by Moran are of the 10¼-in. OD, 80 stage variety. This is the largest operational unit in the field. Bits were 17½-in. and 12¼-in. hard formation three-cone bits — all "off-the-shelf" and with standard water courses.

Standard practice on the Herscher project called for use of a four-blade stabilizer attached to lower bearing of

Toolpusher Dale Erwin on Rig 14, discusses the operation with R. J. Moran, president of the Wichita Falls, Texas-based drilling company. Moran has two rigs in the area and has drilled about 25 wells around Herscher.

Spur of the Texas-Illinois pipeline leading into the compressor station of Natural Gas Storage Company of Illinois at Herscher, Illinois. Framed is Moran Brothers Drilling Company's Rig 14, currently engaged in drilling storage wells. Gas from the Texas-Illinois system is repressured here prior to being pumped back into the ground for storage against use in peak seasons. Natural Gas Storage plans to store up to 90 billion cu ft of gas in the Galesville sand, and an undetermined amount in the Mt. Simon.

GOOD DRILLING IN ILLINOIS

the tool, just above the bit when drilling in 17½-in. hole. This stabilizer was omitted when drilling 12¼-in. hole. Same size tool was used in both instances. Above the 30 ft-long turbodrill was a string (roller) reamer. Five 8-in. drill collars were run in the string above the reamer. Moran used 4½-in. Grade D drill pipe, although use of 5½-in. drill pipe was attempted. Since no change in penetration rate was observed when running the larger diameter string, the contractor reverted back to the original drill pipe.

Water was used as drilling fluid for most of the turbodrilled section. With conventionally-mudded section, weight was held below 11.3 lb per gal. The drilling fluid was pumped downhole at the rate of 800 gal per min about 1200 psi using a 275 input hp mud pump with 12-in. stroke and 5-in. liners, and a 600 input hp pump 16-in. stroke and 7¼-in. liners. Weight on bit was approximately 30,000 lb. At one point the tool successfully circulated a sizable amount of lost circulation material (a leather floc) in the fluid.

Turbodrilling Record Improves

First turbodrilled well in the Herscher project was the Karcher M-3 which required 9½ days to reach a casing point of 1432 ft. A total of 84 drilling hours were required, although some time was lost in repairing the rig and in a lost circulation zone at 600-ft, which required a rotary bit run.

Each succeeding well was completed in less time. The sixth turbodrilled well, the Bartlett M-1 was drilled in 3¾ days with a total of only 35 rotating hours.

The Karcher M-3 used 19 bits to total depth. This included six 17½-in. and seven 12¼-in. bits. On successive holes from 12 to 14 bits were used. This figure includes 8¾-in. jet bits used below the 12¼-in. hole.

Worn bits are usually evidenced by a noticeable drop in penetration rate. When the drill string is rotated from the bottom of the hole by the turbine an increase in rotary speed may mean a dull bit. Recurrent stalling of the turbine is also an indication of a dull bit.

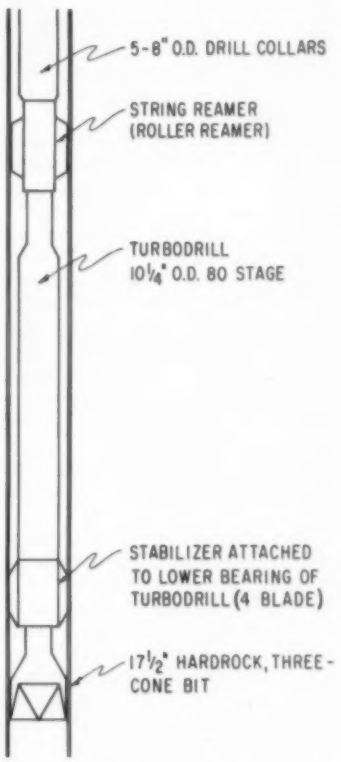
Life of the tool itself is quite good and, for the most part, wear is confined to thrust bearings.

It is estimated that the turbine blading has a life of somewhere between 1000 and 3000 hours, depending on operating conditions. Flow velocities through the turbine blading are on the order of 20 to 40 ft per sec, when drilling fluid sand content is held below 3 or 4 percent, erosion is not a problem. Loads on the radial bearings are relatively small and have lives numbering in hundreds of hours. The thrust bearing carries the highest operating loads of any element in the tool and have a life of from 100 to 200 hours. A single thrust bearing set was used to drill three of the Herscher wells. Standard maintenance procedure calls for measurement of turbodrill thrust bearing clearance each time the tool is out of the hole.

Hole deviation in the 17½ and 12¼-in. hole are held within ¾ deg or less from vertical. Below the turbodrilled section, the 8¾-in. hole deviates 1½ to 3 deg from vertical.

Natural Gas Storage Company, which has drilled some 20 gas storage wells, five water injection wells and several observation wells on the Herscher Dome, claim that drilling time has been cut from 27 days to 10 days.

Moran Brothers is running the turbodrill on a lease-rental basis from the manufacturer. ★ ★ ★


5-8" O.D. DRILL COLLARS
STRING REAMER (ROLLER REAMER)
TURBODRILL 10¼" O.D. 80 STAGE
STABILIZER ATTACHED TO LOWER BEARING OF TURBODRILL (4 BLADE)
17½" HARDROCK, THREE-CONE BIT

Drillstem in the turbodrilled section of Moran drilled wells at Herscher. Drill pipe is 4½-in. grade D.

Russian engineers help

Reds Fill Oil 'Lamps of China'

Communist Chinese claim oil self-sufficiency near; Soviet designed oilfield equipment now in production

COMMUNIST CHINA is making good progress toward self-sufficiency in oil tools and equipment, according to a touring delegation of Russian petroleum experts.

The Soviet group, which spent considerable time in Kansu Province's booming Yumen field, said that the Chinese have already mastered some advanced Russian exploration, drilling and production techniques. Northwest of Yumen, in Sinkiang Province, the Russian method of moving fully-assembled derricks to new drilling sites with teams of tractors is being introduced.

In Shanghai the Russians saw factories fitted out with Soviet machinery manufacturing "bits of the latest design, spare parts for turbodrills and other oil equipment." Use of Soviet style turbodrilling "is being mastered slowly but surely," the Russians report.

Average drilling speed in northwestern China's oil fields is said to have almost doubled with the acquisition of more-powerful "five-diesel" rigs.

"Waterflooding and hydraulic fracturing are being employed advantageously. During the past two years, 82 percent of the 245 hydraulic fracturing jobs were successful, providing an additional 555,000 bbl of oil."

Wells in the Yumen field, which was discovered in 1936, are now being completed at depths down to 9840 ft. Casing program usually provides for a 12-in. surface string to a maximum of 980 ft and a 6-in. producing string.

Yumen drillers, being comparatively inexperienced, have more than their share of troubles, the Russians indicated. Main difficulties are crooked holes, "abandonment of cutters at the bottom of the hole," and "scouring of threaded joints on the drill pipe."

Chinese crews are still quite slow in raising and lowering their drilling tools, the Soviet delegation observed. The Russians conducted demonstrations at one Yumen well to show how the best Soviet crews have organized lifting and lowering operations.

While praising China's overall oil industry development under the Communist regime, the Soviet report made no claims of spectacular discoveries or production gains in 1957. Russian enthusiasm for Chinese oil prospects has been more restrained since the Peking government lowered its 1957 production goal in mid-year from 15,090,000 bbl to 11,250,000 bbl.

The latter total, if achieved last year, would have represented a 29 percent gain over the 8,812,500 bbl produced in 1956. Output in previous years, according to official figures, was 7,470,000 bbl in 1955, 5,917,500 bbl in 1954, 4,665,000 in 1953, 3,270,000 in 1952 and 913,500 in 1949, the first year of the Communist reign.

Prospects for further substantial gains in Chinese oil production brightened recently following new discoveries in the Szechuan Basin in south-central China. The new find is over 1000 miles from the nation's largest oil producing region in the Dzungarian Basin of northwest China. ★ ★

Russian drilling "expert" at the brake of a Chinese rig in the Yumen oil field is demonstrating fast methods of tripping to slower Chinese drilling counterparts.

Adapted from Neftyanik, No. 2, 1958.

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Remedial Treatment of Water Injection Wells

Although there are several methods of improving injectivity, field tests of wells using surface acting agents point to new heights of effectiveness

Donald E. Menzie
Associate Professor of Petroleum Engineering, The University of Oklahoma, Norman, Oklahoma

SEVERAL PROCEDURES may be used to increase injectivity of water into a formation. The basic question is, "What can be done to a water injection well so that it will take more water?"

This problem deals with two types of wells. First, the gradually plugged well, which must not be confused with the gradual decrease in injection rates commonly occurring as a water-flood project progresses, and secondly, the water injection well which lacks a high enough permeability to allow adequate injection rates by use of reasonable injection pressures. Before looking at these conditions, first let us look at the following general methods of improving injectivity in water injection wells. The following methods have been proposed:[2]

1. Shooting with nitroglycerine.
2. Underreaming.
3. Acidizing.
4. Fracturing.
5. Reduction of residual oil saturation in a limited area around the well bore by injection of a volatile solvent with subsequent vaporization.
6. Heating the injection water.
7. In situ combustion.
8. Reduction of clay swelling by coating with an agent.
9. Surface active agents which may increase injectivity due to reduced residual oil saturations, reduced interfacial tension, or perhaps due to changes in wetting of the solids.

The first six of the above have been used by some operators, and these methods are discussed in the literature. No. 7, in situ combustion, has been proposed, since it removes almost all fluids present in the formation. No. 8 and 9 are similar, since the agent used in No. 8 is a surfactant. No. 9 is of principal interest.

Gradual Plugging of the Sand Face

Gradual plugging of the sand face may be masked by changes in reservoir conditions. Swelling of clay minerals when contacted by injected water may cause plugging in the formation. Also, as a water flood approaches the fill-up period, the water injection rates tend to decrease. This is due to the increasing length of the water zone and the necessity of increasing injection pressures to maintain a constant injection rate.

Only the sand-face plugging of the type involving a rapid decrease in the rate of injection and an indication of abnormal behavior of the water-injection well is dealt with here.

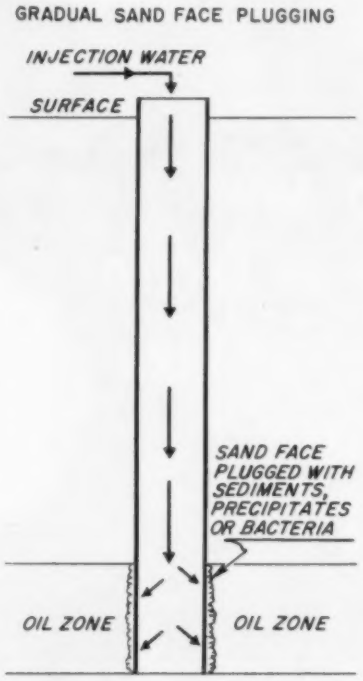

FIG. 1. Gradual sand face plugging, as shown in this water injection well may be caused by swelling of clay minerals, or a deposition of insoluble salts, sediments, precipitates or bacteria. In the majority of cases, this plugging is removed by backflowing — but there are other methods that should be considered.

Backflowing

The accepted method of dealing with a sand-face plug is backflowing the input well. This consists of closing the water supply line and permitting the pressure in the reservoir to force water back into the well bore. The backflow period usually varies from a few hours to a one-day period. The backflow removes the insoluble salts that mechanically block the sand face. The beneficial effects of each backflow are usually excellent at first, but effectiveness decreases as the flood progresses.

Flushing

If backflowing is not satisfactory, then a macaroni string of tubing may be run inside the casing of the input well. The sand face is flushed with a water spray, and the mechanically blocked sand face is cleaned.

For an example, "It may be interesting to note that at times the rate of injection had dropped to what we believed to be alarming proportions within a given amount of time . . ."[9]

Sodium hypochlorite was flushed through the water system and into the sand. All wells were backflowed until all injected fluid had been removed. This backflow period varied from three to eight hours. Various repeated treatments and backflowing resulted in a 20 percent increase in injection rates.

Backflowing of water-injection wells

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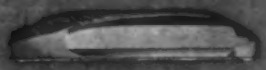
1. WINGS ARE EASIER TO CHANGE—Worn wings can usually be changed without removing the body from the string. Wings are machined to close tolerances to insure interchangeability and proper fit. Corrosion and galling are prevented by "Parkerizing." Wings can be quickly removed or installed even after rough usage and exposure to corrosive mud, salt water, etc.

2. WINGS DO NOT COME OFF IN THE HOLE—Wings are made of ductile iron—a new material with the castability and machinability of gray iron and the mechanical properties of cast steel. This material, plus a positive lock, prevents wings from coming loose in the hole.

3. WINGS ARE EASILY WASHED OVER—Although the use of ductile iron gives the wings greater strength, wash over operations can be accomplished with the use of a conventional wash over shoe. Wings are cored for easier milling and to minimize the amount of material removed. No large pieces to foul up the hole.



4. WINGS ARE CAST ON A HELIX—Casting wings on a helix allows smooth rotation in the hole with *maximum* stabilizing contact with the wall of the bore hole. All contacting surfaces are hard faced with tungsten carbide for maximum resistance to wear.

Servco Model B Stabilizers are available in a complete range of sizes—all of which will accommodate surveying instruments. For complete information see pages 4710 and 4711 in the Composite Catalog or write for Folder.

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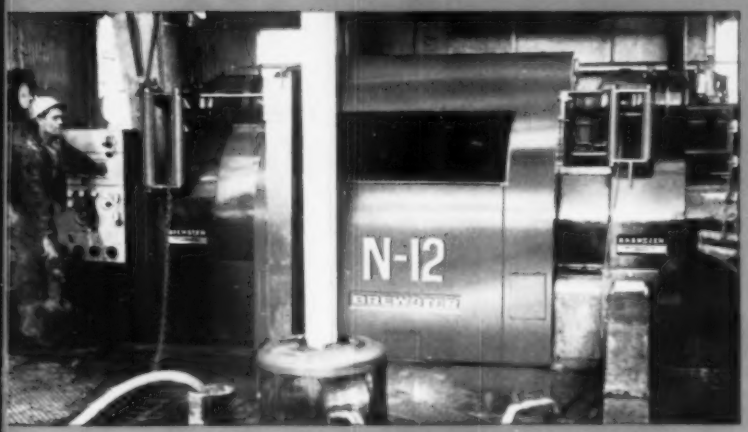


PENROD RIG 42

POWER-PACKED NEW DESIGN BY BREWSTER

Boasting over 100 horsepower for every foot of beam this new Penrod rig is a new concept in barge design. Gone are the frills and showboat accommodations. This new barge will drill to 20,000 feet and packs the equipment to do it in just 30 feet of width and 186 feet of length. Drawing only six feet under way she will go up to most locations without dredging or widening.

Let Brewster quote you on a drawworks designed to your special drilling requirements.

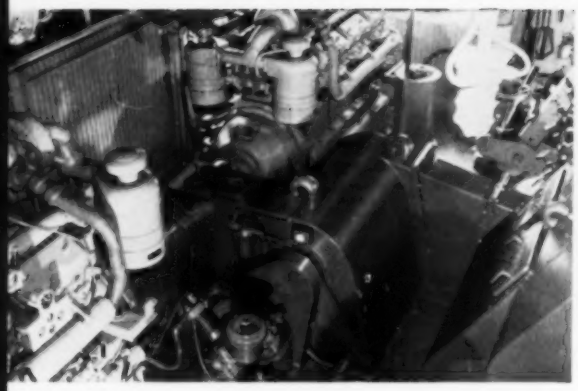
Turn the page to see the other power features of Rig 42

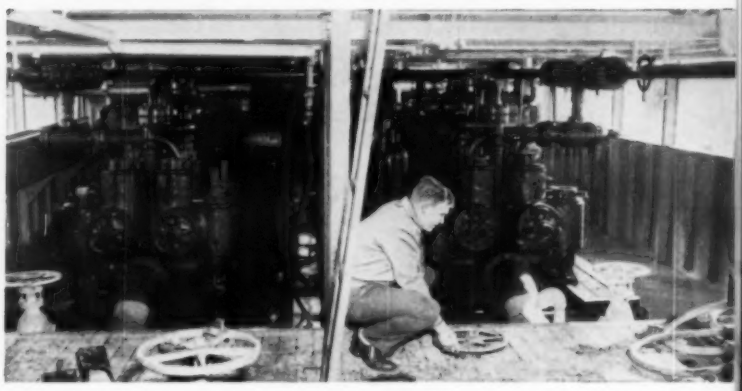
BREWSTER

J. P. Johnson, Superintendent for Penrod Drilling Company who originated the design for Rig 42, says, "This rig was built for maximum use of power, a minimum of barge, maximum rig. Its performance record has been excellent."

Starting top side Rig 42 has a Brewster N-12 Reserve Powered Drawworks. Two "Cat" Turbo charged D-397's furnish the power. A unique offset compound on the N-12 places the engines opposite each other. This shortens the overall drawworks and compound length to just 18' 6".

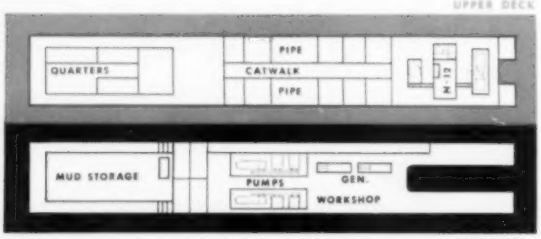
Capable of 20,000 foot drilling the Brewster N-12 has eight forward and two reverse speeds. Four speeds are available at the rotary table. A field proved design, the N-12 turned in a First Hole record of 11,200 feet in eleven days' time including spudding in and crooked hole trouble.





POWER-PACKED COMPOUND was designed by Brewster to fit Rig 42's new concept in barge design. Developing over 1200 horsepower the Turbo charged "Cats" are linked to the drawworks by a minimum of compound and chain, requiring only 10' 8" in depth behind the drawworks. Note how auxiliaries such as the air compressor and oil pumps have been placed to use a minimum of space yet they are completely accessible.

TWO PUMPS WIDE the hull wastes no space yet allows plenty of work room. Each pump is powered by two Turbo Charged D-397 "Cats". The full mud system can be seen in the foreground. Dry mud storage is provided in after section of first deck.



A 500-TON BREWSTER BLOCK and 8SX swivel handle the drilling string. The Rotary Table is a Brewster 27½". This "Matched Equipment" for the Reserve Powered Brewster N-12 gives Rig 42 a balanced team to speed drilling.

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Shreveport, Louisiana

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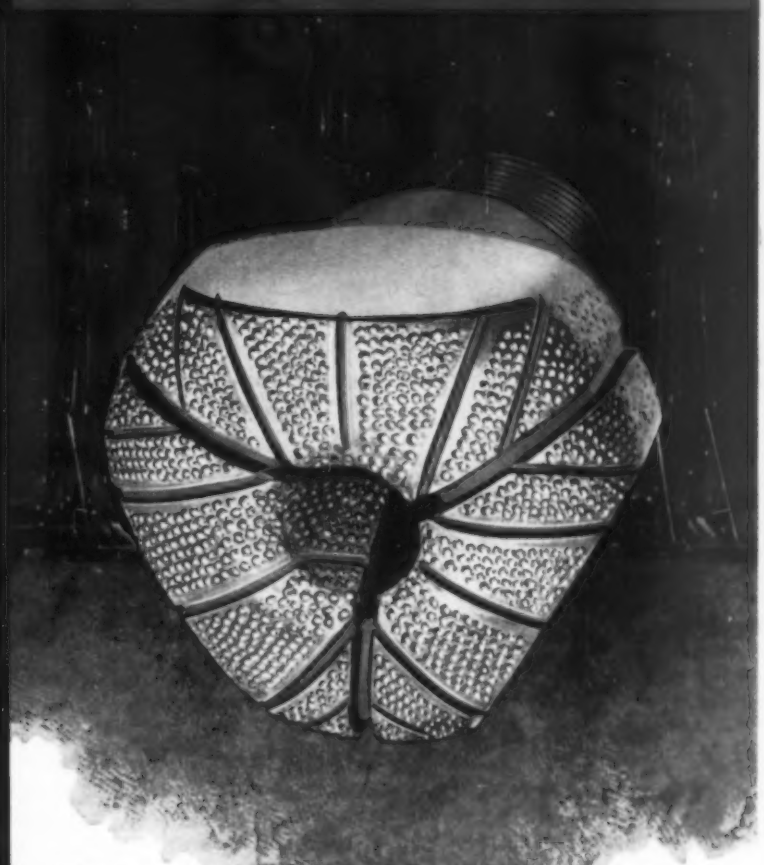

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that were plugged has been performed on many occasions. The beneficial effect of each backflow was excellent at first, but effectiveness decreased as the cumulative water injected increased.

Comparing two operations in the same area (Kansas), one operator, (A), used selective shooting with 5½-in. shells; the other, (B), used 3½-in. shells. One, (A) used fuel oil (3 bbl per ft of pay) in the injection wells prior to introducing water; the other, (B) did not. (A) added a surfactant (20 ppm) and chlorine to the water; (B) did not.

Peak Injection Rates

A	*B*
22 bbl/day/acre	18 bbl/day/acre

Low Injection Rates

16 bbl/day/acre	7 bbl/day/acre

The above procedures used by operator (A) improved by three times the injection rates of water into the reservoir by comparison with wells in the same field which were not treated as listed above.

Acid

Acid is injected in an attempt to dissolve the block or to dissolve part of the reservoir. This treatment is often effective and increases the permeability to water. Any of the previous methods mentioned can be combined with bailing and swabbing of the well to cause water or acid to flow back and forth through the plugged region.

Fracturing

Fracturing has been proposed as a method of breaking through a region around the well bore which has been mechanically plugged. Fracturing has been proposed and used successfully in water floods, but many producers are not disposed to chance the risk of producing a channel or crack which could by-pass the oil zone to the producing well.

Some workers[4] have studied the effect horizontal fractures may have on the water well injectivity and the effect fractures may have on sweep efficiency. All fractures were assumed circular. For 600-ft well spacing, fractures 30 ft in radius at the input well appear to increase the water input appreciably with only a 1 percent decrease in sweep efficiency.

Fluid-loss additives and perforation sealers used during fracturing are recent developments. These increase fracturing efficiency, but there is some doubt as to the control of the fractures.

Several detergents have been proposed as additives to the fracturing fluids, in an effort to increase the efficiency of the treatment.

Additives

A variety of additives can be used today to aid in obtaining a better fracturing job. For example . . . especially in cases where pipe is set through the sand and perforated, one aid is mud cleanout agent. This is being used to help clear the perforations of cement and also clean up mud, water, and foreign materials . . . from drilling the well."[1] The mud cleanout agent is a combination of acid, surfactant, nonemulsifying agent, and corrosion inhibitor. It is theorized that the acid cleans the perforations and shrinks the clays; the water is removed by the surfactant.

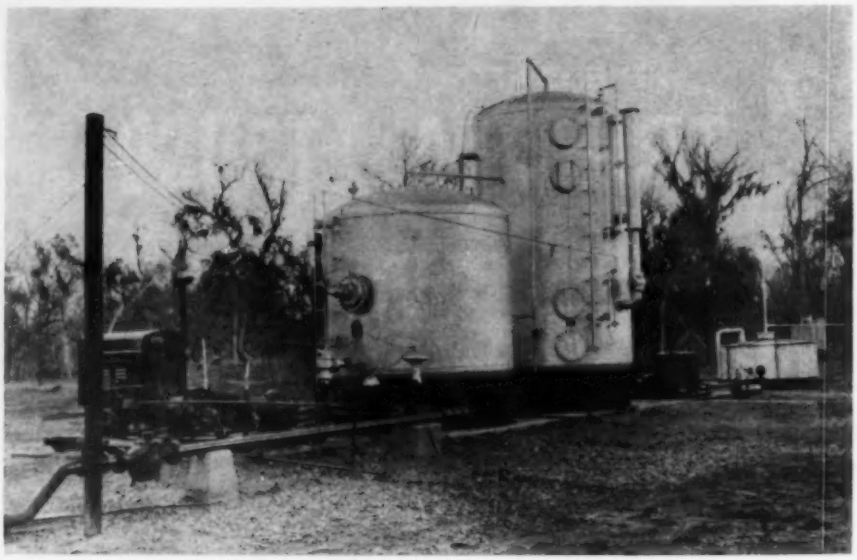

FIG. 2. **Typical water injection set-up.** In background is salt water tank, next the treating tank. Tank in foreground is surge tank. Engine in foreground drives pump to injection well, idling when water exceeds predetermined pressure.

Nitroglycerine

A new approach[2] for wells which have been fractured and still need treatment involves shooting with nitroglycerine. An explosion is detonated after the fracturing treatment, with the hope that horizontal and vertical fractures will result. Liquid nitroglycerine with a safe detonation point is placed in the well bore and the voids created by the fracturing treatment. When the bore hole and the fracture have been filled, the explosive is detonated and newly-formed fractures and crevices extend in all directions.

With this as a general coverage of remedial treatment, let's look at the specific field of surface active agents which have been used in field tests in water injection wells in an attempt to increase injectivity.

Surface Active Agents

Some field tests with detergents as water-flood additives have been conducted primarily to increase oil recovery. Increases in water injection rates have been suggested as a method of increasing ultimate oil production, especially if the increase in water rate is into the less permeable zones of the producing formation.

A field test with a detergent was conducted by the Bureau of Mines.[5] In it, water-input well characteristics were tested before, during, and after detergent injection. These tests[6] were injectivity-index and pressure-decline tests. The pressure-decline test is a proposed method of evaluating the "skin factor" or the permeability of the zone immediately around the well bore to that of the formation as a whole. This test may be used to indicate the change in permeability around the well bore of a water-injection well after such remedial work as formation fracturing or detergent injection.

Two methods were used to inject the detergent into the well:

1. Slug treatment — several gallons within a few minutes,
2. Continuous treatment—low concentration over a period of weeks.

The results showed:

1 well with both types of treatment — little effect.

1 well with slug treatment – effective permeability increased from 2.1 to 2.9 md.

Results of the pressure-decline test on all 9 wells treated with detergent gave 5 wells with increased effective permeability and 4 wells with decreased effective permeability. The injectivity index tests showed 3 wells increased, 3 wells decreased, and 1 remained constant.

There was a suggestion in the results

Which Unibolt stem seat has been in corrosive gas-distillate service for 8 years?

UNIBOLT Christmas tree fittings — tees, crosses, positive chokes, adjustable wing valves — trimmed in exclusive UNIBOLT "SA" Stainless, or made entirely of this special analysis alloy, are winning the fight against corrosive fluids and gases.

Production containing either hydrogen sulphide or carbon dioxide, or both, usually attacks and quickly destroys carbon steel and some alloy steel parts.

A standard UNIBOLT Adjustable Wing Valve, installed on a corrosive well in the Katy Field (Texas Gulf Coast) required replacement of the carbon steel seat in only 45 days. A UNIBOLT "SA" Stainless Valve installed at that time has shown no corrosion damage in eight years. As the above photograph reveals, the 8-year-old stem seat (right) still shows no sign of corrosion, for all practical purposes is as good as the new stem seat (left).

Got any corrosive wells? A UNIBOLT representative will gladly give you full particulars and case histories on "SA" (Special Analysis) Stainless.

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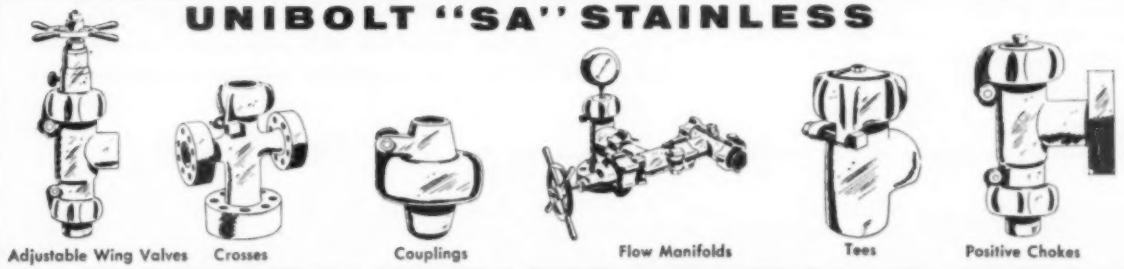

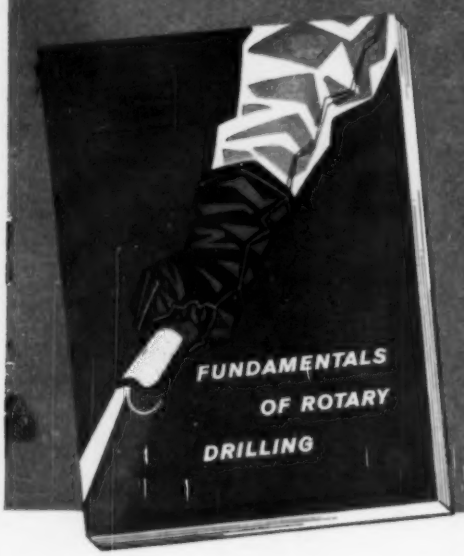

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TABLE 1b. Water Injection Well Treatments.

No.	Agent Volume, gal	Carrier fluid	Carrier fluid Volume, bbl	Agent Concentration, %	Condition of well—Before	Condition of well—After	Comments
1	50	Fresh water	9	15	New for H_2O	30 bbl	Cable tool, 2 yr old
2	50	Fresh water	7	18	30 bbl/day	132 bbl/day	Cable tool, 2 yr old
3	28	Fresh water	28	3	Original pres aft 2 weeks		Cable tool, new well
4	—	Raw & SW flush	0	100	600-800 psi	100 psi aft 5 min	Rotary, new well
5	—	Raw & SW flush	0	100	1600 psi	750 psi	Rotary, new well
6	—	Raw & SW flush	0	100	975-500 psi	—	Rotary, new well
7	—	Raw & SW flush	0	100	1800-1400 psi	50 psi aft 1 min	Rotary, new well
8	—	FW & SW flush	20	6	1300 psi	Vacuum	—
9	100	FW & SW flush	40	—	6 bbl/min @ 1400		Max. pump capacity
10	50	Fresh water	20	—	Murky water	Clear water	Water supply well
11	28	Raw	0	100	Gravity feed	1/3 more water	Rotary, FW mud

of this field test that the use of a detergent in a water-injection well would be more effective in the relatively impermeable sand. It was proposed that zones of low permeability previously not being flooded were penetrated by the detergent flood water.

Another surfactant has been proposed[13] for use with hard waters. Hard-water scales deposited on the equipment have been a recognized problem spot for years. Scale preventive compounds are good for carbonates and sulfates of calcium, magnesium, and strontium, but are not effective for barium scale.

Certain strains of bacteria such as "sulfate reducers" increase corrosion and decrease water-injection rates. Soluble iron reacts with hydrogen sulfide from the bacteria thus forming insoluble iron sulfide. This may cause decreased injection rates or plugging.

A relatively new water-soluble surfactant[12] is now available for remedial work in low injection-rate water wells. This surface active agent used in 10 to 50 ppm concentrations will reduce interfacial tension between brine and oil to ⅓ its original value. Precipitates or suspended matter in the water are filmed quickly, and growth of the particles is retarded. Some agents include bactericides to be used against organisms.

Any surface active agent may be introduced into the suction side of the injection pump of a water-disposal system or into the water-flood injection system.

Tables 1, 2 and 3 are summaries of some field tests of the use of various surface active agents in water injection and disposal wells. No commercial names are attached to the products, since in some cases the tests are of an experimental nature and the sales products are not yet sufficiently developed to be marketed.

Table 1 shows the results of 11 field tests of an oil-soluble, water-dispersible surface active agent. All 11 tests except No. 10 are on water-injection wells for waterflooding. No. 10 is a water-supply well in which the water from the well was not satisfactory for injection.

The surfactant used in all the tests of Table 1 is classed as a mud cleanout agent and water-block removal agent. The agent was used in all tests except the one case, in an effort to increase the

TABLE 1a. Water Injection Well Treatments.

No.	Field	State	Formation	Perforating data
1	Nowata	Oklahoma	Bartlesville	open hole
2	Nowata	Oklahoma	Bartlesville	open hole
3	Nowata	Oklahoma	Bartlesville	1167-1190 ft
4	Mt. Vernon	Oklahoma	Red Fork Sand	approx. 4500 ft
5	Mt. Vernon	Oklahoma	Red Fork Sand	approx. 4500 ft
6	Mt. Vernon	Oklahoma	Red Fork Sand	approx. 4500 ft
7	Mt. Vernon	Oklahoma	Red Fork Sand	approx. 4500 ft
8	—	Kansas	Topeka	2071-2088 ft
9	Cowley Co.	Kansas	Bartlesville	45 ft open hole
10	Cowley Co.	Kansas	Bartlesville	—
11	Archer Co.	Texas	Strawn	open hole

TABLE 2. Water Injection Well Treatments.

No.	Type well	Field	State	Agent	Before—Rate, bbl/day	Before—Pres, psi	After—Rate, bbl/day	After—Pres, psi
1	disposal	Fitts	Okla	3 pts/day	450	gravity	all lease wtr	vacuum
2	disposal	OC Area	Okla	2 qts/day	540	750	all lease wtr	500
3	input	—	Okla	2 qts/day	51	810	190	750
4	input	—	Okla	2 qts/day	130	—	198	—
5	input	—	Kansas	10-50 ppm	1100	600	1340	70
6	disposal	—	Texas	—	450	700	750	700
7	input	—	Okla	10 gal	190	950	275	900
8	input	—	Okla	10 gal	400	800	810	700
9	input	—	Okla	10 gal	120	900	900	750
10	input	—	Okla	10 gal	165	800	900	750
11	input	—	Okla	10 gal	100	900	950	750
12	input	—	Okla	10 gal	60	900	110	800
13	input	—	Okla	10 gal	200	900	650	800
14	input	—	Okla	10 gal	5	900	265	750
15	input	—	Okla	10 gal	3	950	335	450

TABLE 3. Water Injection Well Treatments. (Bureau of Mines Tests)

No.	Field	State	Formation	Agent	Carrier fluid	After	Comments
1	Grover	Okla	Bartlesville	Slug and cont	Fresh and salt	Little change	—
2	Grover	Okla	Bartlesville	Slug 10 gal	Fresh and salt	Large increase	Orig pres aft 7 weeks
3	Grover	Okla	Bartlesville	Cont 20 ppm	Fresh and salt	Masked	—
4	Grover	Okla	Bartlesville	Cont 45-60 ppm	Fresh and salt	34% increase	Temporary
5	Grover	Okla	Bartlesville	Cont 25 ppm	Fresh and salt	11% increase	—

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water injection rate. The action of the surface active agent is theorized to be beneficial in that:

1. The agent reduces the interfacial tension between the oil and the water, with the result that the oil saturation near the well bore is removed.

2. A layer of the surface active agent is spread around any movable mud or clay particles. The agent coats the solids with liquid and moves these solids away from the well bore.

In test No. 10, the water-supply well was treated to prevent the production of murky water. The cleanout agent was introduced in an attempt to remove enough of the clays and mud so that clear water would be produced from the supply well.

Although not all of the conditions are established for selective use of the agents, it is apparent that for certain applications, treatment with this surfactant was successful. It would seem desirable to conduct more tests involving variable conditions and different applications of this agent.

Table 2 presents the published results[10,11] of tests of the use of a surface active agent in input and disposal wells. In some tests the agent was introduced as a slug, and in other tests as continuous injection at lower concentrations. In all cases presented, the injection rate was increased or the injection pressure was reduced.

Table 3 is a summary of the Bureau of Mines field tests of a surface active agent. As reported, either the changes were small or the injection rate returned to the original values after a few weeks.

Summary

Results of the field tests on surface active agents applied to increase water-injection rates appear to be encouraging but not complete. There are many types of surfactants; some are definitely better than others. At this time, it is not fully understood how the agents work or what changes take place in the formation. All of the agents have the common effect of reducing interfacial tension between the liquids, but some of the agents, for undetermined reasons, appear to be more successful than others in improving the water-injection rates.

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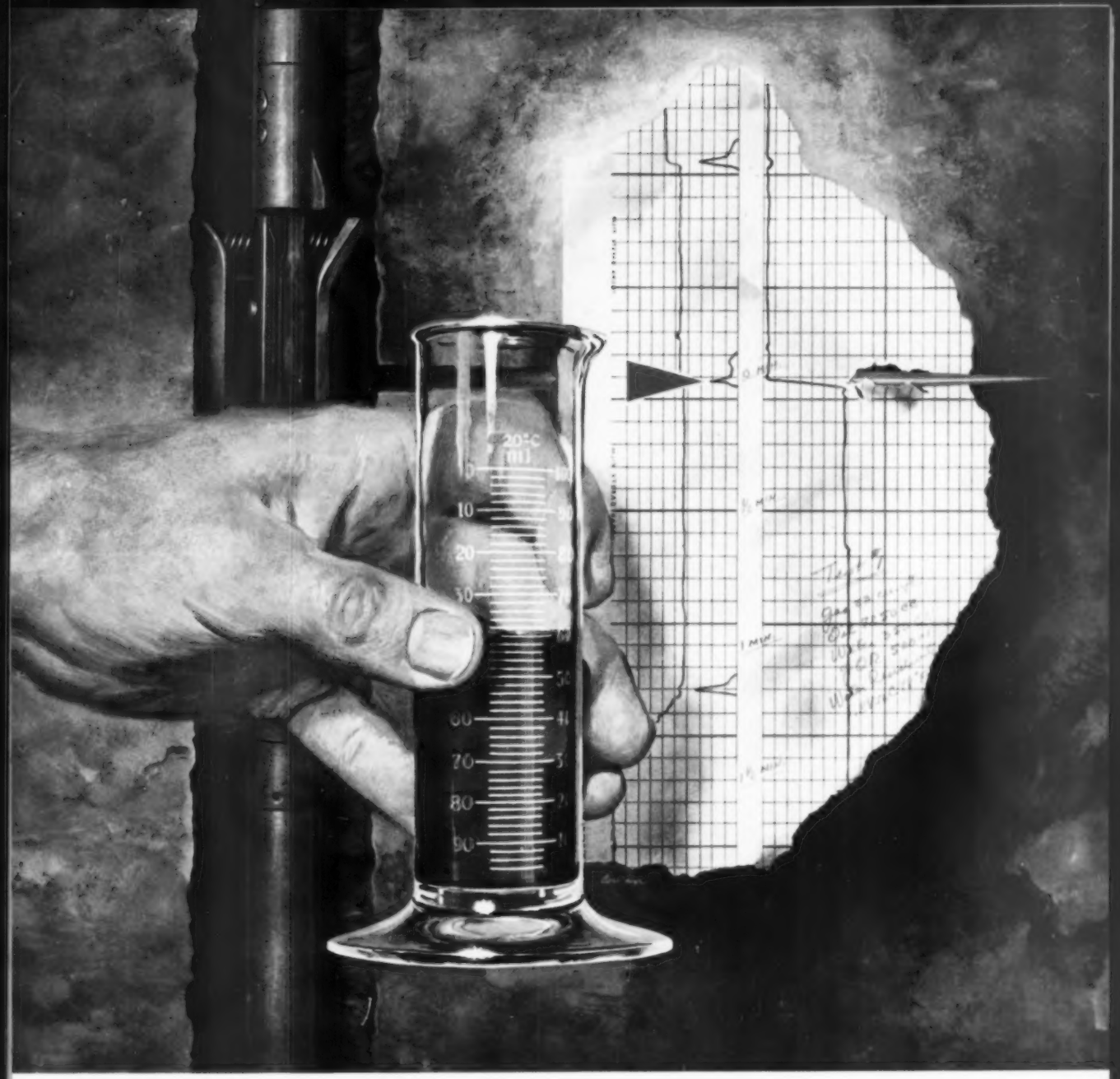

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Oil Tool Developer Floyd Scott, Retires

Floyd L. Scott, director of the Research Engineering Department and member of the board of directors of Hughes Tool Company, retired August 1.

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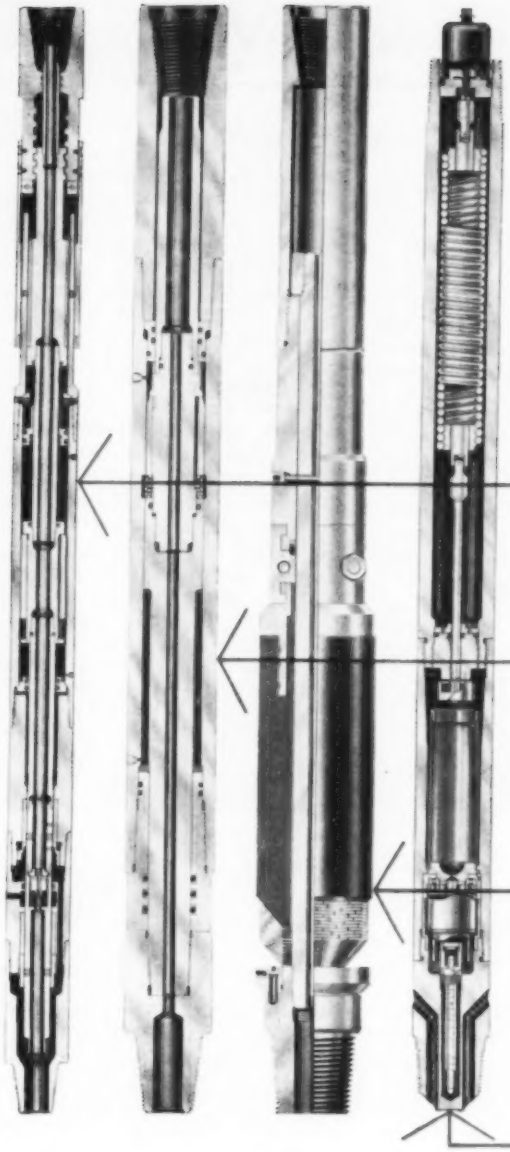

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The contract, which is for 15 years with an option for an additional 5 years, requires Pan Am International to develop these areas to the fullest extent and as rapidly as possible. Fifty wells will be drilled within the first year, 10 of these in the Sarmiento area and 40 in the Cerro Dragon area. Five rigs will be employed.

Depending on the results of the first year's program, Pan Am International will drill an additional 100 wells within the second year, and build a pipeline. Twenty of the additional wells would be drilled in Sarmiento and 80 at Cerro Dragon. Ten rigs would be used during the second year.

Pan American International will assume the entire risk in the undertaking and will provide the funds for all drilling, development and construction.

ALASKA

BLM Delivers Leases to 10,000; Bids Invited on Gubik Gas Area

Processing of more than 10,000 applications for oil and gas leases in Alaska is in full operation. The bids had stacked up in the Bureau of Land Management offices in the two months following a May 2 suspension order.

Leasing is now open in several areas, and includes regions covered by inland waters, as provided in recent legislation passed by Congress. Also open for leasing are certain lands within the Kenai Moose Range.

Lease rentals on acreage applied before May 3 will carry a 25-cents-per-acre rental for the first year. These will carry a 50-cent rental next year, as will all acreage applied for after May 3. All leases will have the newly-approved 12.5 percent royalty rate.

Gubik Bids Open September 3

Some 16,000 acres of potentially gas productive land around the Gubik structure has been opened for competitive leasing by Secretary of Interior Fred Seaton. Bids were to be opened at 11 a.m. September 3 in Washington.

Four million acres adjoining the Gubik field are also to be opened to non-competitive leasing. Gubik lies in the uppermost part of the Alaskan territory and above the Arctic Circle.

Colorado O&G Drilling Third Yakutat Test

Colorado Oil & Gas Corporation has started a third well near Yakutat on the southern coast of Alaska where it owns 50 percent interest in 1,100,000 acres. The well, projected to a depth of 11,000 ft, will test a combination seismic and subsurface feature. The wildcat is near two other wells drilled by the company; both had encouraging oil and gas shows.

TEXAS

Lion Lists Brazoria Find

Lion Oil Company (Monsanto Chemical), and Republic Natural Gas Company have completed their McDonald No. 1 as a gas-condensate discovery in Brazoria County, Texas. Located in the Joseph White survey, the new wildcat well is approximately 8 miles west of the town of West Columbia. Official tests indicate an open flow potential of 27,000,000 cu ft of gas per day and 18½ bbl of condensate per MMcf of gas. Production is from the lower Frio sand through perforations from 9922 to 9934 ft. Shut-in pressure was 4880 psi.

AFGHANISTAN

Russians to Seek Afghan Oil

The Afghan National Assembly has approved an agreement between the Soviet Union and the Afghanistan government to permit Russian geologists to conduct oil exploration surveys in this mountainous country lying to the east of Iran.

OKLAHOMA

Arbuckle Confirmer in Harper County Finds Lansing Oil

A north offset to Sinclair Oil and Gas Company's important Arbuckle discovery in Harper County has recovered flowing oil from the Lansing (Pennsylvanian). The confirmation attempt is the No. 1 Rosa Lee Kuhn, located 7 miles north of Buffalo. The Lansing was topped at 4574 ft and flowed gas on a 20 min drillstem test at the rate 18,000 cu ft per day from 4560 to 4605 ft. Mud surfaced in 5½ min and oil in 7 min flowing at an unestimated rate. The well is to go to the Arbuckle at about 7900 ft before completing.

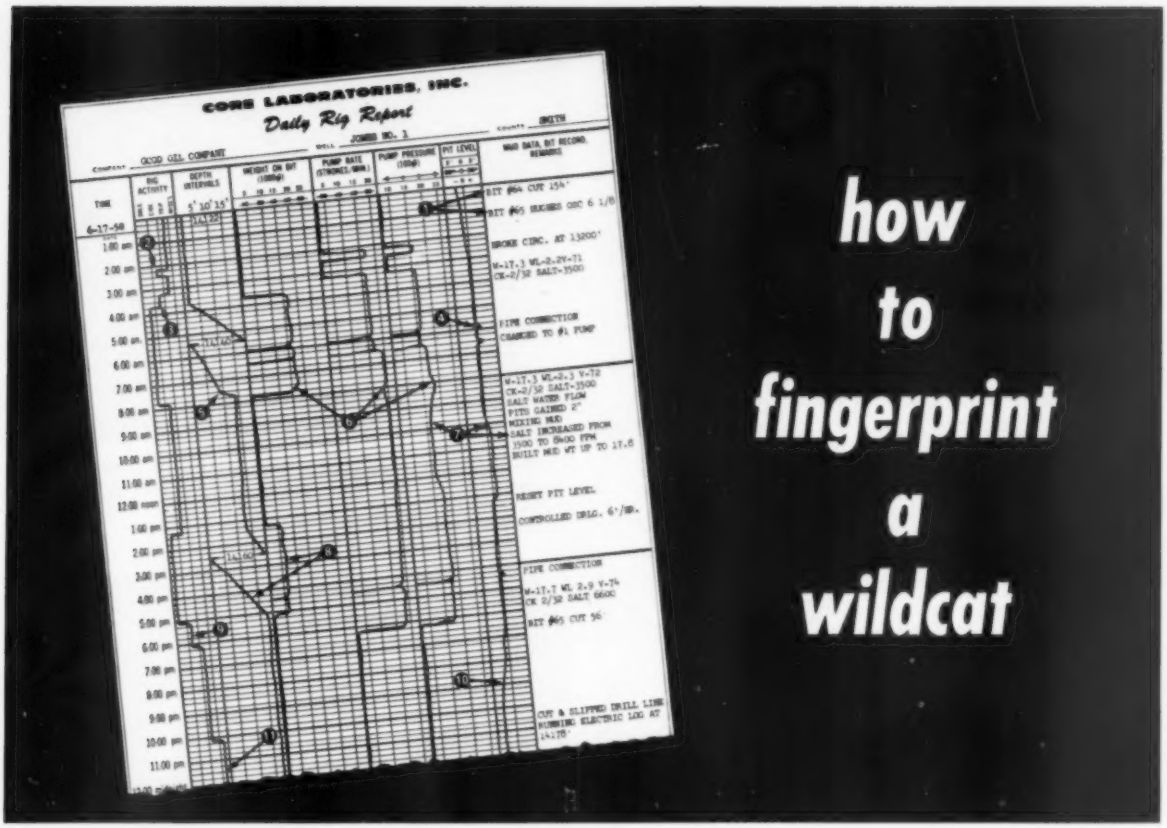
Sinclair opened Arbuckle production in July with its No. 1 Holcomb, which was completed for 314 bbl of 48 deg oil per day from six intervals from 7664 to 7717 ft. The well is 31 miles from nearest Arbuckle production and has suggested a possible Arbuckle trend extending up into Kansas.

Atlantic Pumps Mississippian Oil from Jackson County 'Cat

Atlantic Refining Company's No. 1 Hulett, NE SE NW 5-1n-23w, is pumping 57 bbl of oil daily from perforations in the Mississippian at 6690-720 ft and 6752-60 ft. The rank test is 19 miles west of the Altus pool and is located in Jackson County. Total depth of the well is 7701 ft with 4½-in. pipe set at 6820 ft. Results of final pumping tests are not yet complete.

Great Plains Completes Lincoln County Discovery

A new oil find in Lincoln County, located about 1 mile southeast of the West Davenport pool — but separated by several dry holes — has been completed by Great Plains Petroleum Corporation. The well is the No. 1 Elmer Johnston. It flowed, following fracturing, 380 bbl of oil in 8½ hours on a half-inch choke from open hole at 3585-600 ft. Flow pressure was 380 psi. Total depth was 3600 ft with 4½-in. pipe set at 3585 ft. Operator is drilling a confirmation well.



Core Lab's new *Daily Rig Report* is the "hottest" Well Logging Service refinement developed in years.

The source material for this 24-hour, graphical presentation of downhole and surface activity originates at the central instrument panel of Core Lab logging units.

All continuous strip chart recordings and associated information are carefully summarized, accurately plotted, and presented to the operator at the well site. At a glance, he can comprehend 24 hours of rig activity. For example, here's what the Report above reveals about a day in the life of a wildcat —

(1)-Bit record — footage cut by old bit; type and size of new bit. (2)-While making trip back to bottom, crew stopped at 13,200' and broke circulation for 15 minutes. (3)-Circulated and conditioned mud for 30 minutes after getting back on bottom. (4)-Made connection; slight gain in mud suction pit when pumps were off. (5)-7:35 AM; change in slope of depth curve indicated drilling break at 14,149'. (6)-Loss of weight on bit, combined with slight initial reduction in pump rate and initial gain in pump pressure at the time of drilling break, indicated probable high-pressure sand. (7)-Gain in mud level and higher filtrate salinity, combined with delayed loss of pump pressure, indicated definite salt water flow. (8)-Controlled drilling rate of 6 feet per hour, accomplished with only 7,000 pounds weight on bit, indicated drilling was probably still in high-pressure sand. (9)-Circulated and conditioned mud for one hour prior to trip. (10)-Normal loss of mud due to hole fill-up while coming out with drill pipe. (11)-Shut down to change drill line and run electric log, while out of hole at 14,178 feet.

Note: The new Daily Rig Report does not replace Core Lab's traditional Grapholog (hydrocarbon index, lithology, physical characteristics of mud, etc.). To the contrary, it greatly supplements the wealth of information available through Well Logging Service.

CORE LABORATORIES, INC.

801 CORE STREET DALLAS 7 TEXAS

CORE LAB

DALLAS FT WORTH HOUSTON MIDLAND ABILENE SAN ANGELO PAMPA AMARILLO MONAHANS LUBBOCK HOBBS CORPUS CHRISTI VICTORIA McALLEN SAN ANTONIO SHREVEPORT TYLER EL DORADO HATTIESBURG JACKSON TULSA OKLAHOMA CITY WICHITA FALLS BARTLESVILLE WICHITA LIBERAL LAFAYETTE NEW ORLEANS DENVER STERLING CRAIG CASPER WORLAND KIMBALL WILLISTON FARMINGTON LOS ANGELES BAKERSFIELD LONG BEACH CALGARY EDMONTON REGINA VENEZUELA S A

Up-To-Date Checklist of Dowell Acid Services–to Help You Solve Production Problems

Dowell acidized the first oil well, using inhibited hydrochloric acid, in 1932. Since then, Dowell engineers have encountered thousands of well stimulation problems where acid—properly modified and applied—proved to be the best method of increasing production. This experience has led to the development of a wide variety of improved acids, techniques and addition agents.

For example, Dowell has developed two acids with retarded action for wells producing from fast-reacting limestone pays. These acids are especially effective in vugular and oolitic formations; and in formations containing natural fractures, or exhibiting inter-crystalline porosity.

Where the producing formation is a dense slow-acting dolomite, wells often respond better to acid treatment if a Dowell intensifying agent is added.

Emulsions and silicate swelling need no longer restrict production following an acid job. Dowell has developed addition agents to combat these problems.

There is no need to rule out acid treatments if your well is producing from a sandstone. Many sands show good solubility in Mud Acid.

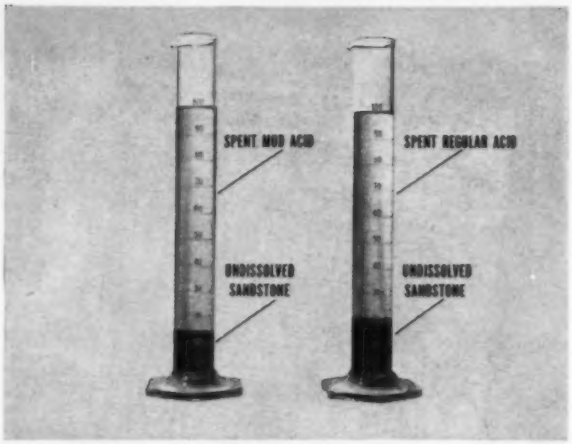
The search for improved chemicals and new acidizing techniques continues today at Dowell. Recently, Dowell worked with operators in the Mid-Continent and Permian Basin areas to perfect the use of magnesium pellets to heat acid, as the acid is pumped into producing formations. By creating heat in this manner, Dowell has been able to remove scale and deposits unaffected by other treatments.

When you specify Dowell you get the benefit of more years of experience in oil well acidizing than you can get from any other service company.

Dowell's major acid services are briefly described at the right. For service, call any of the 165 Dowell service points and offices. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

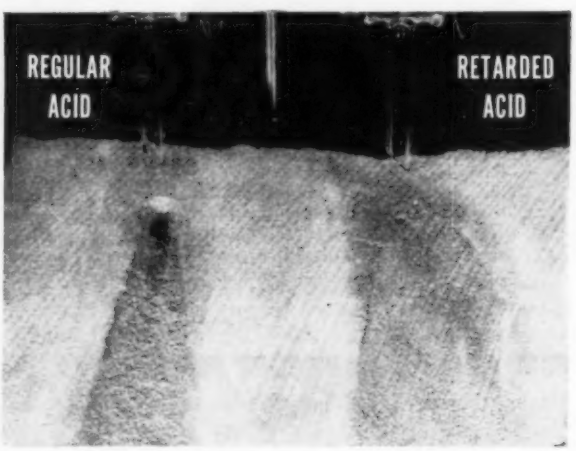
Services for the oil industry DOWELL

A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY



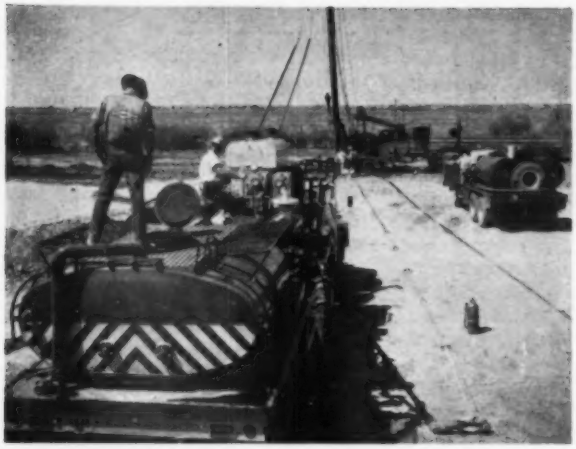
1. MUD ACID contains a special fluoride compound designed to help dissolve and disintegrate clays and bentonites. It is recommended for use in mud removal operations and for acidizing certain sandstone formations.

4. XFWM ACID contains three agents designed to reduce surface tension, reduce silicate swelling and prevent emulsions. It is commonly used as a service by itself; but is also used as a spearhead with other treatments.

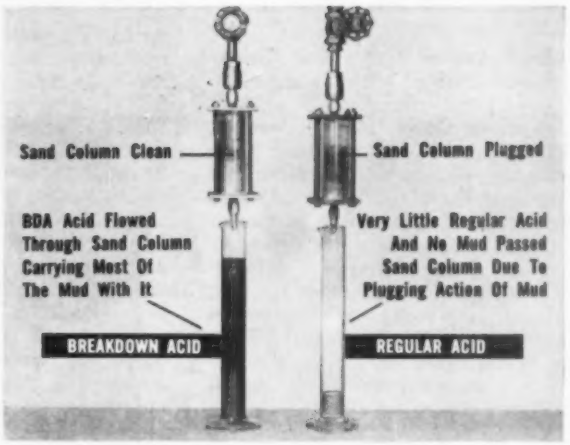


7. RETARDED ACID contains an addition agent that greatly slows down the acid action—as shown here. It is designed to create a deeper drainage area in fast-reacting limestone formations than does regular acid.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

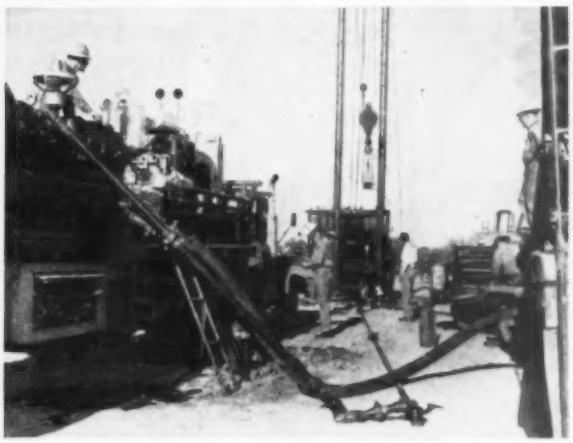


2. DOWELL REGULAR ACID is the basis for Dowell acidizing services. It is a 15 per cent by weight inhibited hydrochloric acid solution. One thousand gallons of regular Dowell acid will dissolve 10.8 cubic feet of pure limestone.


Sand Column Clean
Sand Column Plugged
BDA Acid Flowed Through Sand Column Carrying Most Of The Mud With It
Very Little Regular Acid And No Mud Passed Sand Column Due To Plugging Action Of Mud
BREAKDOWN ACID
REGULAR ACID

3. BREAKDOWN ACID (BDA*) contains agents that make it especially effective in breaking down and penetrating mud cake, and the formation. It is designed to be used as a spearhead for both fracturing and acidizing treatments.

5. SILICATE CONTROL ACID contains an agent designed to control the swelling of certain silicates, clays and bentonites. It is also effective in preventing or breaking oil-in-water emulsions that sometimes occur following an acid treatment.



6. HEATBLAST is a new Dowell service designed to remove heavy hydrocarbons and mineral scales near the well bore by increasing the bottom hole temperature of the well. It uses a jel solution carrying magnesium pellets and a specially inhibited acid.

8. ACID PETROFRAC* is a Dowell fracturing service that uses an acid-oil emulsion as the fracturing fluid. This fluid, however, is often used on highly soluble formations—without sand—as a retarded acid.

9. STABILIZED ACID is designed to prevent the precipitation of iron hydroxide from spent acid. It is widely used to acidize waterflood input wells. It has also proved helpful in producing wells where iron salts are present.

*Dowell Trademark

Exploration

INDIA

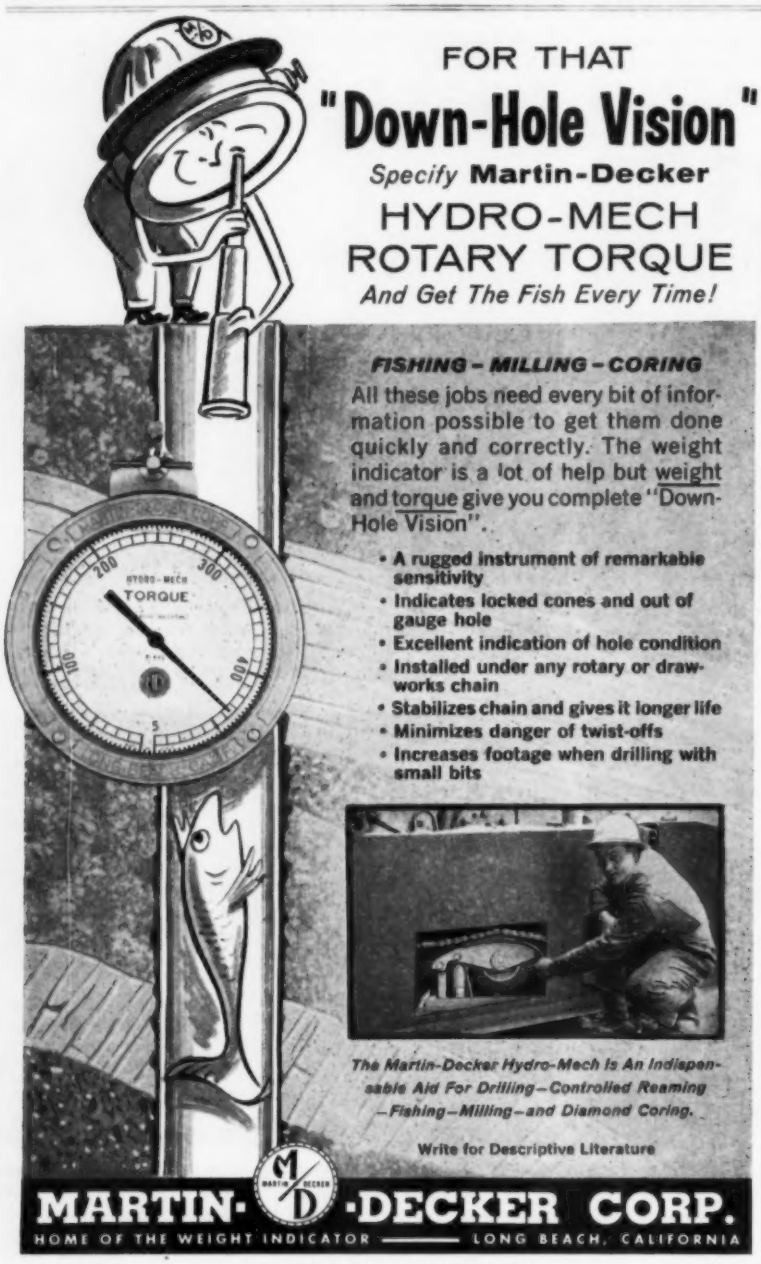
Assam Counts Exploration Gains

Total depth of 42 wells drilled by Assam Oil Company at Nahorkatiya and Moran during the last five years is 459,364 ft, or about 87 miles, more than the distance between Delhi and Mathura. Latest new well in the area is Well No. 33, completed at a depth of 10,280 ft in June. In Moran, another oil area of Upper Assam, Well No. 9 reached 11,789 ft in June. The first well at Nahorkatiya was completed at a depth of 11,715 ft in June 1953.

A total of over 200 wells, including a very large number of test wells, all unproductive, were drilled in India before the discovery of oil at Nahorkatiya. Of the 33 wells drilled so far at Nahorkatiya area five produced no oil and two are mainly gas producers. Although the average depth of the wells is about 10,614 ft, the deepest in the area, Well No. 12, reached a depth of 13,060 ft. A feature of drilling in the area is speed: Well No. 27, depth 9405 ft, was completed in 20 days.

Well No. 34 at Nahorkatiya, is now drilling below 3310 ft. Arrangements are also in progress to prepare the site at the location of Well No. 35.

Well No. 9 at Moran, drilling of which was completed on June 17, is awaiting the production test. Drillers are now at work on Well No. 10.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All these jobs need every bit of information possible to get them done quickly and correctly. The weight indicator is a lot of help but weight and torque give you complete "Down-Hole Vision".
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NEW MEXICO

Texaco Adds 50,000 Acres to Albuquerque Holdings

The Texas Company has acquired leases on a 50,000 acre spread in townships 9, 10 and 11n, R1w, and R1, 2 and 3e, just west of Albuquerque in Bernalillo County. Oil and gas leases were purchased from R. L. Herrera and A. A. Michael for a reported $61,891. Earlier this year, the company acquired 40,000 acres in the Alameda grant, just north of Albuquerque.

ALBERTA

Devon-Palmer Would Link Okotoks, Chestermere Fields

Devon-Palmer Oils Ltd. has started a well centrally located in a sulfur-bearing gas area which, if successful would link Okotoks and Chestermere fields.

The new well, Devon-Palmer TGSCO Calgary East Number 10-30 LSD 10, 30,23,28 W-4, is located 3½ miles east of the Calgary city limits and 12 miles north of the Okotoks gas field which already has nine wells producing. The new well is owned jointly by the Texas Gulf Sulphur Company, Inc. and Devon-Palmer and is four miles south of the Mobil Canamerican Chestermere well in which the two companies have a 25 percent interest.

PHILIPPINES

White Eagle Sells Stock To Push Exploration Program

White Eagle Overseas Oil Company, Inc., a Philippine corporation, has begun preliminary exploration on 770,000 acres under oil exploration concessions in five different locations in the Philippines. A public sale of $2,500,000 of common stock was recently made in the Manila investment market and quickly oversubscribed. Since the sale the market price has risen considerably, with some trading 140 percent above the subscription price.

White Eagle Overseas is a subsidiary of White Eagle Oil Company of Tulsa, Oklahoma. Four geologists are now on the company payroll conducting surface studies. In addition, work has begun under a contract with the Hunting Group of Toronto for photogeological analysis of the acreage.

White Eagle Oil Company will direct the operation of its new affiliate under a long term management contract.

ERRATUM

"A Promising Method of Permeability Log Determination," by S. T. Yuster and A. S. Odeh, was published in the August issue. Photographs and biographies of the authors, appearing on page B-37, were inadvertantly interchanged.

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Here's the handiest combination of efficiency and flexibility ever developed in a tubing swab. The BJ Hydrodynamic Swab has a simple, two-piece body and a pair of either of two types of rubbers that fit onto it. This is all you need for any kind of swabbing job that comes your way. There is less to buy, fewer parts and accessories to fool with. Yet, you'll be able to swab faster, with greater recovery, and with fewer rubber changes.

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Better, Faster, More Economical Swabbing!

VERSATILITY. There is complete interchangeability of the two rubber types. One steel body serves for both. You simply unscrew the guide nut, let the rubbers slide off, and slip the replacements on.

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FASTER FALLING. No ports to cause drag. On descent, rubbers fit loosely inside tubing; when the swab is pulled up, the rubbers expand to form a positive seal. You get in and out of the tubing in a hurry.

BETTER SWABBING. BJ swab rubbers are designed to pull the greatest possible loads – yet they have an exclusive flexible feature that allows them to adjust to light or medium loads too.

ADVANCED DESIGN. Smaller and much easier to handle because there is no bulky arrangement of ball and ports. The rubbers themselves act as check valves. When you replace a rubber you automatically get a new "valve."

LONGER LIFE. Body lasts longer because there's no check valve to wear out. Rubbers last longer because of the fact that there's a clearance between the tubing and the descending rubbers.

POPULAR TUBING SIZES. In each of the two rubber styles there are sizes for 2", 2½", and 3" tubing. The two larger sizes are interchangeable on a single swab body.

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Buy two dozen BJ swab rubbers – either the cup type or disc type or any combination of the two – and you will receive a brand-new swab body **absolutely free!** This offer is for a limited time only, so don't miss out. See your favorite supply dealer or your BJ field man today.

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RUNNING TOUR with MEN in the INDUSTRY

R. W. Reiss

▸ **Royal W. Reiss** has been named engineer in charge of the oil and gas operations of Aluminum Company of America, succeeding **Louis W. Minturn** who has resigned from Alcoa to become an exploration consultant in the petroleum industry and who will continue to serve Alcoa in a consulting capacity.

Reiss, prior to his new appointment, held the post of general superintendent and chief petroleum engineer of Alcoa's oil and gas operations.

N. J. Clark

▸ **Norman J. Clark,** formerly assistant manager in charge of engineering and consulting for Core Laboratories, Incorporated, Dallas, Texas, has formed his own independent petroleum reservoir engineering and appraisal service. His new independent engineering service, with headquarters at 2840 Republic National Bank Building, Dallas, specializes in the latest techniques of secondary recovery of oil. Also available is organization and management consultation in reservoir and production engineering both for domestic and international operations.

▸ **Boyd Guthrie,** after 27 years of service with the United States Bureau of Mines, has accepted a position with Socony-Mobil Oil Company in Paulsboro, New Jersey, as a consultant on oil recovery techniques.

▸ **J. N. Mendenhall,** general manager of domestic crude oil production for The Atlantic Refining Company, has retired after almost forty years of service with the firm. He is succeeded by **Edgar Kraus,** who was named assistant general manager.

▸ **John D. Albright** has been named assistant chief petroleum engineer for Cities Service Oil Company's production division. Albright was previously special engineer in the production division.

▸ **Frank W. Beach** has been appointed division engineer for Cities Service Oil Company at Oil Hill, Kansas.

Beach succeeds Wm. H. Cantrell, who was killed in the tornado that hit the El Dorado, Kansas, area. Beach joined Cities Service in 1941.

Dr. Siro Vazquez

▸ **Dr. Siro Vázquez** of Caracas, Venezuela, has been appointed co-ordinator of the Standard Oil Company (New Jersey) producing and coordination department. Dr. Vázquez has been a director of Creole Petroleum Corporation. He succeeded **M. A. Wright,** who was elected to the board of directors of Jersey Standard.

J. M. Stevenson

▸ **John M. Stevenson,** formerly senior mechanical engineer for Delhi-Taylor Oil Corporation, Dallas, Texas, has formed his own independent engineering service. Prior to joining Delhi in 1956, he was for 6 years a field development engineer in pipe line and oil field problems for the Youngstown Sheet and Tube Company. During this period, he spent one year as chief engineer for United Machine Company of Fort Worth, Texas. Stevenson's independent engineering service, with headquarters at 1610 First National Bank Building, Dallas, is set up to handle on a contract basis a variety of specialized problems in the fields of petroleum production, pipelines, and corrosion, as well as in new product development, welding, materials, inspection, and patent development.

▸ **Fred McCown** has been appointed head of T. T. Eason & Company, drilling division of Eason Oil Company. He was previously in the petroleum department of First National City Bank of New York.

▸ **Charles J. Bryce** is now affiliated with the International Brown Drilling Corporation. He will serve as manager of the company's Venezuelan operations.

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What's doing in DRILLING

Multiple-Well Platform In Gulf of Paria

Drilling is underway on a new stationary multiple-well platform built in Trinidad's oil-rich Gulf of Paria. The platform mounts a derrick that will drill six holes from one position and then skid itself ahead to drill another six holes. Built for Texaco Trinidad, Inc. by Raymond International, Inc., the 52 by 157 ft platform is designed

for drilling 36 wells and can be expanded to handle 72 wells. It is supported on 144-ft long prestressed concrete piles and stands in 68 ft of water.

The Texaco platform joins a fast-growing group of rigs that are making the Gulf of Paria one of the busiest offshore drilling areas in the world. Derricks sprouting on both the Trinidad and Venezuelan sides of the Gulf indicate that the area may soon rival the Middle East's Persian Gulf.

New Mexico Contractor Stacks Ten Rigs

One of the largest drilling contractors operating in New Mexico and West Texas has announced its withdrawal from the drilling business. A statement by R. "Cotton" Makin, president of Makin Drilling Company, informed that the company has suspended operations indefinitely, insofar as the contract drilling division is concerned.

In the announcement, Makin contended that "contract drilling prices today do not allow a sufficient profit return on the large capital investment necessary to conduct this type of business. The 10 rigs will be stored at the Makin Drilling Company yard in Hobbs until such time as the current artificially depressed price situation or other prevailing conditions change, thereby warranting resumption of the company's operations."

Intex Oil to Drill Navy's Teapot Dome

From a list of 31 bidders, the Navy has picked Intex Oil Company of Bakersfield, California, to operate the drilling program at the Teapot Dome reserve in Wyoming. This will be the first drilling activity in 30 years at the Navy-administered oil field. Terms of the agreement call for the Navy to pay the costs of operation plus either a flat fee of $500 per month or 6 percent of the net profits, whichever is greater.

The Navy pointed out that Intex was selected after various qualifications of all bidders were considered, rather than simply choosing the low bid. Bids for the program ranged from 1 percent to 33 percent of the net profits.

Joint Offshore Safety Committee Named

A new committee has been named to aid in preparing a manual on safe practices in offshore oil operations. The group is a joint advisory committee of the American Association of Oilwell Drilling Contractors and the Offshore Operators committee. Contents of the new book will include recommended practices for raising, lowering, and moving offshore drilling platforms. The committee will be a standing group to review and update the manual when necessary.

Offshore Rig Starts Work in Lake Erie

Put to work recently as a forerunner of drilling activity on the Great Lakes was a 2500 sq ft offshore rig owned by the New York State Natural Gas Company. The unit is in operation on Lake Erie off the Ohio lakeshore, exploring formations of natural gas with a cable tool rig. The welded steel barge, known as Argonyn I, consists of five pontoons, 8 by 10 by 50 ft, joined together by "I" beams and plate steel as a working platform. Four hydraulically-activated tubular legs measuring 130 ft when fully extended are lowered to the lake bottom for maximum stability during drilling operations.

West Texas Deep Test Logged

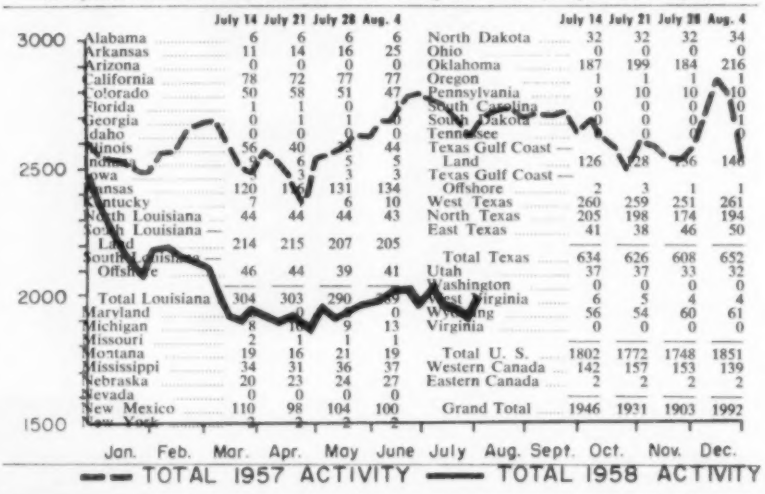
At a record depth of 22,834 ft, Schlumberger recently logged the Phillips Petroleum Company, No. 1 "EE" University, in Pecos County, Texas. Services run at this depth were the electrical log, microlog-caliper, gamma ray-neutron log, and continuous dipmeter log. These were run as a continuation of a logging program which has included the running of all of the above logs at intermediate depths during the drilling of the well.

The maximum temperature encountered in surveying to the record depth was 318 F. In spite of this high temperature, the logs obtained were technically satisfactory.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	July 14	July 21	July 28	Aug. 4
Alabama	6	6	6	6
Arkansas	11	14	16	25
Arizona	0	0	0	0
California	78	72	77	77
Colorado	50	58	51	47
Florida	1	1	0	1
Georgia	0	1	1	0
Idaho	0	0	0	0
Illinois	56	40	43	44
Indiana	5	6	5	5
Iowa	3	3	3	3
Kansas	120	119	131	134
Kentucky	7	7	6	10
North Louisiana	44	44	44	43
South Louisiana — Land	214	215	207	205
South Louisiana — Offshore	46	44	39	41
Total Louisiana	304	303	290	289
Maryland	0	0	0	0
Michigan	8	10	9	13
Missouri	2	1	1	1
Montana	19	16	21	19
Mississippi	34	31	36	37
Nebraska	20	23	24	27
Nevada	0	0	0	0
New Mexico	110	98	104	100
New York	2	2	2	2
North Dakota	32	32	32	34
Ohio	0	0	0	0
Oklahoma	187	199	184	216
Oregon	1	1	1	1
Pennsylvania	9	10	10	10
South Carolina	0	0	0	0
South Dakota	0	0	0	1
Tennessee	0	0	0	0
Texas Gulf Coast — Land	126	128	136	146
Texas Gulf Coast — Offshore	2	3	1	1
West Texas	260	259	251	261
North Texas	205	198	174	194
East Texas	41	38	46	50
Total Texas	634	626	608	652
Utah	37	37	33	32
Washington	0	0	0	0
West Virginia	6	5	4	4
Wyoming	56	54	60	61
Virginia	0	0	0	0
Total U. S.	1802	1772	1748	1851
Western Canada	142	157	153	139
Eastern Canada	2	2	2	2
Grand Total	1946	1931	1903	1992



New Electric Rigs Ordered for Overseas

Three orders from overseas oil companies for electric drives to be used in offshore and land oil well drilling have been received by General Electric's locomotive and car equipment department. One order, for National Supply Company, was received through Royal Dutch Shell's New York purchasing agent, Asiatic Petroleum. The other two were placed by Nuovo Pignone, Italian licensee for Ideco, one of the Dresser Industries.

The Shell order is destined for offshore drilling operations in the mouth of the Niger River in Nigeria. The equipment will first go to England to National Supply's subsidiary, Oil Well Equipment Company, for installation on the drilling equipment.

Equipment included in the two identical Nuovo Pignone orders is for use in the Sicilian oil fields. To be installed on two skid-mounted land rigs, the equipment is being shipped to the Nuovo Pignone factory in Florence, Italy. The rigs are designed for drilling to depths of 10,000 ft.

Submersible Drilling Barge Christened

A new submersible drilling barge, the "Leonard Glade," has been christened and placed into service for Producers Drilling Company of New Orleans. The barge is a slotted-type steel submersible unit 185 ft long, 50 ft wide, and 14 ft deep. Built by Levingston Shipbuilding Company, the barge is designed to drill wells to a depth of 18,000 ft plus and is fully equipped to operate in remote swamp locations in a maximum water depth of 12 ft.

The president of Producers Drilling is J. L. Goldman, vice president and general manager is W. F. Youngblood, and Leonard Glade is secretary-treasurer. The firm has headquarters in New Orleans.

Japan Arabian to Drill Despite Mideast Unrest

The president of the recently formed Japan Arabian Oil Company has said that his firm would go ahead with plans to drill for oil early next year, despite turbulent Mideast events. Taro Yamashita, who signed an agreement earlier this month for offshore exploration and drilling rights near the oil-rich area of Kuwait, said he doubted that his company's plans would be affected even if the coup should spread further.

Stekoll Opens Canadian Office

Opening of engineering and operations offices at Estevan in Saskatchewan, Canada, for Stekoll Drilling Company has been announced. Charles Johnson, an associate of the company for almost 14 years, has been moved to Estevan from Texas as general superintendent for Canadian operations. Assistant superintendent is Jack Zimmell, with Stekoll for 23 years, while W. B. Woodall, 8-year employee, will become manager of the Estevan office.

Stekoll Drilling, a 32-year-old independent producer, recently completed its seventh successful Canadian oil well. Current operations center is Saskatchewan and Alberta provinces. Land offices have been established in Regina and Calgary.

The Dope Bucket . . .

. . . Midland Exploration Company, Tulsa, has bought rigs and equipment of Exploration Drilling & Oil Company, also of Tulsa. B. E. Groenewold has been elected vice president; he is also a new vice president of Sharp Drilling Company. . . . Brewster-Bartle Drilling Company has reported that during the first six months of this year, its rigs have been in operation 86 percent of available rig days. . . . Gerald W. Gearhart, formerly with Criswell Drilling Company, and Grant Canaday, Jr., formerly with Cooperative Refinery Association, have formed the Gearhart & Canaday Drilling Company, at Wichita, Kansas.

Progress Report No. 6: Anadarko Basin No. 1, Caddo County, Oklahoma

CASING TROUBLES BURDEN DEEP TEST

IN MID-JULY, Howell & Howell ran and cemented the intermediate casing string in its Anadarko Basin No. 1, the Caddo County, Oklahoma, deep test scheduled to drill to 24,000 ft. (*The Petroleum Engineer*, March 1958, page B-31.) The casing string was run as a liner from 7324 ft to 17,447 ft in 12-in. hole.

After the liner was run and cemented, drilling was resumed with 8⅝-in. hole and had continued to 17,732 ft when considerable quantities of gas broke into the hole. It was determined that the gas had broken in around the top of the liner, where the cement had probably been weakened by gas contamination during the cementing job. The decision was made to squeeze the liner at top and bottom.

A drillable cement retainer was set at 17,250 ft and the bottom of the liner was squeezed to a maximum pressure of 7100 psi. While preparing to set a retainer above the top of the liner, quantities of shale cuttings were found. A 13⅜-in. cement retainer was finally set at 7205 ft and operations were begun to squeeze the top of the liner.

While the casing was being pressured up prior to breaking down the formation for the squeeze, the 13⅜-in. casing ruptured at 510 ft at a pressure of approximately 3600 psi. Instead of attempting to repair the casing rupture, it was decided to set another string of casing to be tied into the top of the 9⅝-in. liner at 7324 ft and run to the surface. This string consisted of approximately 5700 ft of 10¾-in. casing and 1624 ft of 9⅝-in. casing. It was cemented with 850 sacks of Portland cement.

After this string of casing was cemented, drilling was again resumed. As of August 13, the bit was working back to bottom through shale bridges. Mud weight had been increased to 13 lb per gal and gas was at a minimum.

Original plans call for the well to continue to 24,000 ft in 8⅝-in. hole. The well was spudded in November 1957 with a 24-in. hole drilled to 540 ft. A string of 20-in. OD, 72.16 lb-per-ft line pipe was run and cemented to the surface. A 17½-in. hole was then drilled to 7903 ft and cased with a special string of 13⅜-in. OD, N-80, 85 lb-per-ft casing. Drilling then continued with 12-in. hole to 17,682 ft before the intermediate string of 9⅝-in. casing was run.

It's New

Drilling – Producing Equipment

New Line of Tubing Swabs Introduced

A new line of tubing swabs is announced by Byron Jackson Tools, Inc. The line features both cup-type rubbers and the multi-disk type. For a particular tubing size an operator needs but one of the swab bodies and a pair of each of the 2 types of rubbers to handle any kind of tubing swabbing job. To minimize friction wear and to speed the drop to the bottom, swabs are designed to allow an annular clearance going down. When the swab is pulled, this clearance closes up and gives a positive seal.

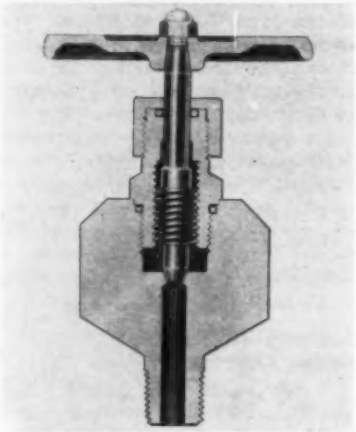
The cup-type swab is designed to pull the greatest loads. The cup is covered with a thick layer of tough, synthetic rubber, and is made up of a series of vertical steel wires encircled by 2 steel reinforcing rings — one at the middle and one at the bottom. The one at the mid-section is the load-compensating ring on which the wires pivot and adjust themselves to allow the least amount of wall friction needed to form a positive seal when a load is being pulled.

The disk-type rubber is engineered for maximum effectiveness in pulling sand-laden fluids or for any general-purpose swabbing where an overload feature is desirable. Going in the hole, the 16 bevelled-edged disks that make up the 2 rubbers sweep upward to speed the swab's descent. Coming out of the hole, the disks are pulled out against the tubing wall with the right pressure to hold the load. If the swab becomes overloaded, the disks automatically release fluid until equilibrium is restored. *Byron Jackson Tools, Inc.*

Circle number (1) on reply card.

Needle Valve with O-Ring Seals

A new ¼-in. angle needle valve, featuring O-ring seals on the stem and body, has been announced by Garrett Oil Tools, Inc. The O-ring seals eliminate the need for stuffing boxes. The body of the valve is machined from hexagon stainless steel



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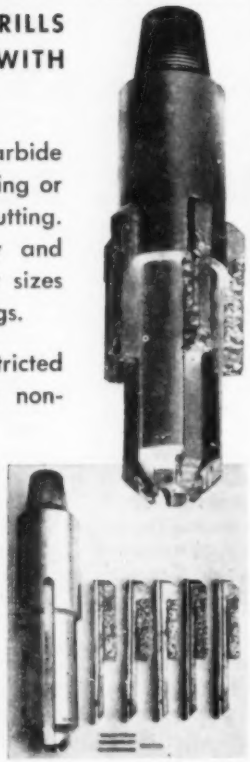
Cutting blades of sintered tungsten carbide aggregate are accurately centered in casing or liner by pilot nose for rapid, even cutting. Interchangeable blades can be quickly and easily fitted into a wide range of body sizes with tools commonly found on drilling rigs.

Positive signal of dulled blades by restricted circulation prevents loss of rig time in non-productive rotation.



Write for complete information and prices on Kinzbach Pilot Speedmill Liner Cutter and other milling tools.

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MOVE Rigs and set 'em up FASTER with SIMPLEX SCREW JACKS

Many drillers are saving time by permanently attaching Simplex Screw Jacks to the underside of their rig floor. When the rig is to be moved, turnbuckle bracing is unfastened and jack is swung up, out of way. At new location, jack is swung down, turnbuckles attached and jack is ready to level rig. Jack can't get lost, is always available for use.

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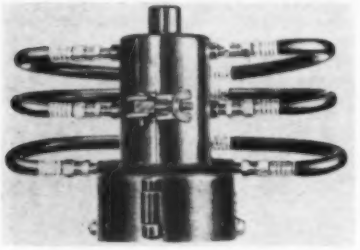
bar stock, while the adjusting nuts and stem are stainless steel. The valve is designed for maximum working pressure of 5000 psi, or a maximum temperature of 150 F. It is supplied with a ¼-in. NPT male inlet and ¼-in. NPT female outlet. *Garrett Oil Tools, Inc.*

Circle number (2) on reply card.

All-Purpose Line Cleaner

Recently placed on the market is a line cleaner called "Jet Away," manufactured and distributed by Bowen Itco, Inc. It cleans regardless of line speed and will clean line and apply rust inhibitor in one operation. Cleaning action is accomplished by the forcing of air, water, or steam through 3 funnel shaped orifices, which produces a thin high velocity jet at



each of the cleaning and drying ports. It will clean any type or size of line or cable, sand lines, conductor cables, and swabbing lines, and will keep polish rods on all types of pumping units clean.

The cleaner is constructed of high grade aluminum alloy, heat treated and machined. At points of wear non-sparking bushings are inserted. The unit may be positioned on top of drill pipe, well head, or lubricator. *Bowen Itco, Inc.*

Circle number (3) on reply card.

Iron Sludge Reduced by Fe Acid

Halliburton's Fe Acid is designed to help stop the plugging action of reddish-brown sludge which may precipitate from spent hydrochloric acid. Its application is primarily for treating water disposal and waterflood wells where deposits of iron oxides, sulfides, and hydroxides from the water have collected on the formation face. Such iron compounds can be dissolved by ordinary acids, but are dropped from solution when the acid is spent. Fe Acid dissolves the iron and keeps it dissolved for a longer period. The result is ample time for removal work or easier cleanout operations and lower injection pressures. *Halliburton Oil Well Cementing Company.*

Circle number (4) on reply card.

Liquid Level Controls

Precise control of liquid level is obtained with new type single-stage, narrow-differential liquid level controls recently added to the Magnetrol line. Small movement between make-break contacts provides high sensitivity to level change. The units will control liquids of specific gravity 0.30 and up, at temperatures to 500 F and pressures to 5000 psi.

Displacers are available in many materials including Karbate, porcelain, and stainless steels. With stainless steel displacers, interface applications are also possible. *Magnetrol, Inc.*

Circle number (5) on reply card.

New JENSEN Rotary Balanced JACK offers:

SAFE, EASY RACK-AND-PINION COUNTERBALANCE OPERATED BY ONE MAN WORKING ON THE GROUND

Unique Jensen rack-and-pinion system assures speedy weight adjustments, gives both lead and lag counterbalance. And Jensen Rotary Jacks are simple to install on flat concrete surfaces or on simplified steel skids — to make your well easier and less costly to equip.

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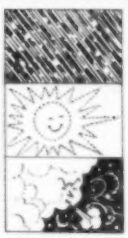
JENSEN JACKS



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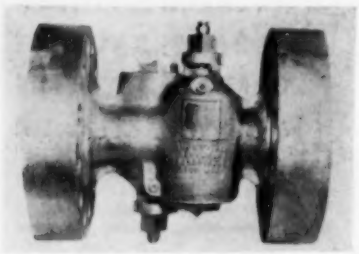
New Equipment

Valves for Dual Completion

A new line of Hypreseal dual completion and recessed body valves — used primarily on Christmas tree installations for dual-producing zones — are now available from Rockwell. The valves embody the basic Rockwell-Nordstrom valve principles of pressure lubrication and port grooving in an advanced design particularly suitable for high pressures, elevated temperatures, and other severe conditions.



The dual completion valves come in 1½, 1¾, 2, and 2½-in. sizes at 3000 and 5000 psi working pressure. The recessed body valves come in 1½, 1¾, 2, and 2½-in. sizes at 2000 and 3000 psi working pressure. *Rockwell Manufacturing Company.*

Circle number (6) on reply card.

Extended Cycle-Rate Pumping Unit

An increase in the cycle rate of Axelson's 4-ft Hydrax hydraulic pumping unit provides a more versatile unit for varying field production requirements. The unit, manufactured by the Axelson Manufacturing Company, a division of U. S. Industries, Inc., has been modified to allow an extended cycle rate from 6 to 9 cycles per min. This design provides high volume production at minimum cost to the operator without destroying the inherent advantages of hydraulic pumping. *Axelson Manufacturing Company.*

Circle number (7) on reply card.

Solid Block Christmas Tree

A new composite Christmas tree has been developed by Cameron Iron Works, Inc., with the cooperation of companies associated with the Royal Dutch/Shell group. The new tree is a single string solid block tree valve with swabbing valve, choke, and flowline valve, plus gin pole socket and small threaded outlets for pressure control equipment and sampling. The tree takes up only 20 percent of the space required by conventional trees of

the same pressure rating and size, yet provides 10 percent more flow-way because of the oversize bore feature.

First trees of this type in the 3000 psi working pressure range have been purchased to be installed in Lake Maracaibo. The tree is so compact that it can be covered completely by a slip-on cover, which reduces possible damage due to collision in the lake. Design also makes it possible for the flowline to parallel the casing down to a depth in the lake which will give ample ship clearance. *Cameron Iron Works, Inc.*

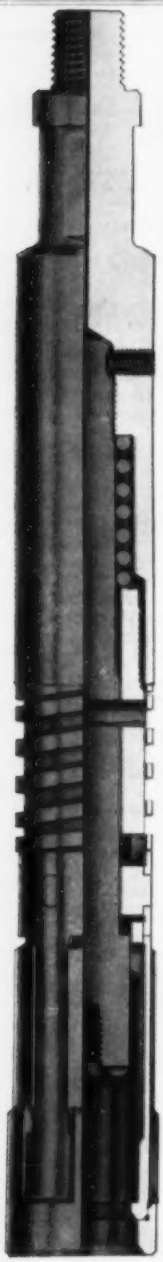
Circle number (8) on reply card.

Bactericide for Waterflood Systems

New Nalco 322 is a combination bactericide and corrosion inhibitor recently announced by National Aluminate Corporation. The product was developed primarily to provide waterflood operators with a chemical that will control sulfate-reducing bacteria and other organisms in brine systems. It is said to be equally effective in salt water disposal systems.

The product is a dark amber, organic liquid packaged and shipped in non-returnable, 55-gal drums. Normal dosage range is 10 to 25 ppm when the product is fed continuously to a non-recirculating brine system as in waterflood or disposal operations. *National Aluminate Corporation.*

Circle number (9) on reply card.



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JUC — for pulling subsurface controls with short fishing necks requiring down jarring to release slips or dogs without releasing pulling tool from fishing neck

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Drilling-Producing Literature

Magnetic and Motorized Valves

A new 24-page catalog issued by The Mercoid Corporation illustrates and lists specifications of magnetic and motorized valves for use with air, water, gas, steam, oil and refrigerants. Also included are solenoid coil rating tables. Another feature consists of 2 flow charts, one for liquid, the other for compressible fluids. Dimensional drawings are included. *The Mercoid Corporation.*

Circle number (10) on reply card.

Inert Gas Producing Equipment

A description of the entire line of packaged inert gas producing equipment manufactured by Southwest Industries, Inc. is contained in a 4-page brochure published by the company. In it are included inert gas generators, nitrogen generators, carbon dioxide generators, carbon dioxide removal units, gas purifiers, gas drying equipment, and compressors and storage systems. *Southwest Industries, Inc.*

Circle number (11) on reply card.

Offshore Equipment Catalog

A new equipment catalog has been published by Joe Stine, Inc. The 20-page publication features hydraulic equipment manufactured by the company for offshore operations. Hydraulic equipment described includes barge spud jacks, yoke-type spud jacks, rig skidding jacks, casing drivers, and hose reels. Also described are mud systems, bunk houses, utility houses, derricks and substructures, drilling equipment, and prestressed concrete manufacturing equipment. *Joe Stine, Inc.*

Circle number (12) on reply card.

Instant Antifoams Samples and Information

A 3-page information sheet and free samples of new Hodag instant antifoams are available from Hodag Chemical Corporation. Antifoams are available in many different formulations to suit specific requirements. The information sheet includes features of the antifoams, when and how to use them, what quantities to use, and general theory behind their use. The antifoams come in concentrated liquid, flake or powder form and are used as received or added to water to form a stable stock emulsion. *Hodag Chemical Corporation.*

Circle number (13) on reply card.

Review of Well Logging Methods

Schlumberger has published a new and comprehensive review of its well logging methods entitled "Introduction to Schlumberger Well Logging." The book is intended as a text for those persons who wish to make a study of logging methods. This document provides an up-to-date review of the abundance of literature dealing with all logging methods. The various logging services offered by Schlumberger are discussed in some detail, together with essential methods of interpretation. The discussion is kept as simple and clear as possible, with a minimum of mathematics. For those interested in making a more advanced study, the book includes a comprehensive bibliography. *Schlumberger Well Surveying Corporation.*

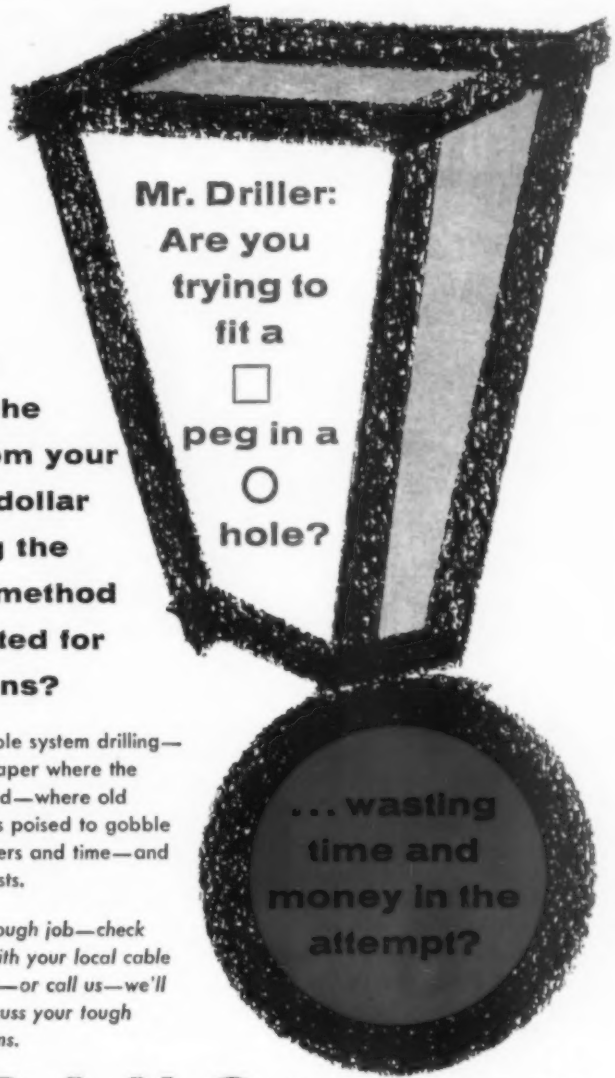
Circle number (14) on reply card.

Meter Tube Catalog

A new 20-page catalog details features and specifications of Daniel Flangnek standard meter tubes. Formerly custom items, meter tubes can be ordered as standardized components of oil and gas flow-measurement systems, knowing only the size, catalog number, and plate bore. Standard units in stock are sizes 2 to 6 in., pressures 150, 300, and 600 psi ASA.

The catalog also includes specifications on Daniel orifice flange meter tubes, 3 section units, high pressure meter tubes, special end modifications, complete metering stations, power station units, and special materials. *Daniel Orifice Fitting Company.*

Circle number (15) on reply card.



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Investigate cable system drilling—you'll drill cheaper where the going is rugged—where old mother earth is poised to gobble up tools, tempers and time—and inflate your costs.

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LANE-WELLS AND ELGEN JOIN FORCES

Lane-Wells Company, a division of Dresser Industries, Inc., and Elgen Corporation have joined forces in a new service organization, according to a joint statement by J. B. O'Connor, president of Dresser, John J. Neale, president of Lane-Wells, and Kirby Gee, president of Elgen Corporation.

The organization will continue to be known as Lane-Wells Company and will have its new head offices in Houston, Texas. The company will offer the advanced Elgen Electrolog and accessory services in addition to the complete line of nuclear logging, perforating, and other wireline services already offered by Lane-Wells.

John J. Neale will continue as president of the company with Kirby Gee as vice president in charge of operations. Other officers include J. D. Hughes, vice president in charge of sales, John H. Zauner, vice president and technical director, and R. W. Keener, vice president.

The existing Elgen facilities and personnel in Dallas will be utilized by the expanded organization to facilitate the broader operations. The Dallas sales office of Lane-Wells Company, under the direction of Dan McLendon, has been made a part of the head office sales operations of the company. An important change in the new organization is a reduction in the geographical size of the divisions and creation of three new divisions with headquarters in New Orleans, Denver, and Midland. These, with existing divisions headed in Houston, Oklahoma City, and Paramount, California, will give the company six divisions.

In announcing the merger, J. B. O'Connor said that it was evidence of Dresser's faith in the good health and growth of the petroleum industry, adding that the recent slump in petroleum activity has in no way slowed down the program of expansion of the Dresser family.

John J. Neale, head of the new organization, stated that Elgen brings 30 logging and perforating units to the union. New services will be added to these units to offer more complete service in the search for and production of oil and gas.

Founder and president of Elgen Corporation, Kirby Gee, said that the new organization will permit acceleration of the research already undertaken by Elgen, and promised several new tools to be made available soon.

Helmsmen of the new Lane-Wells-Elgen union are (left to right) Kirby Gee, vice president in charge of operations; J. B. O'Connor, president of Dresser Industries, Inc., and, John J. Neale, president of Lane-Wells Company.

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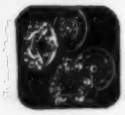

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world's largest family of valves

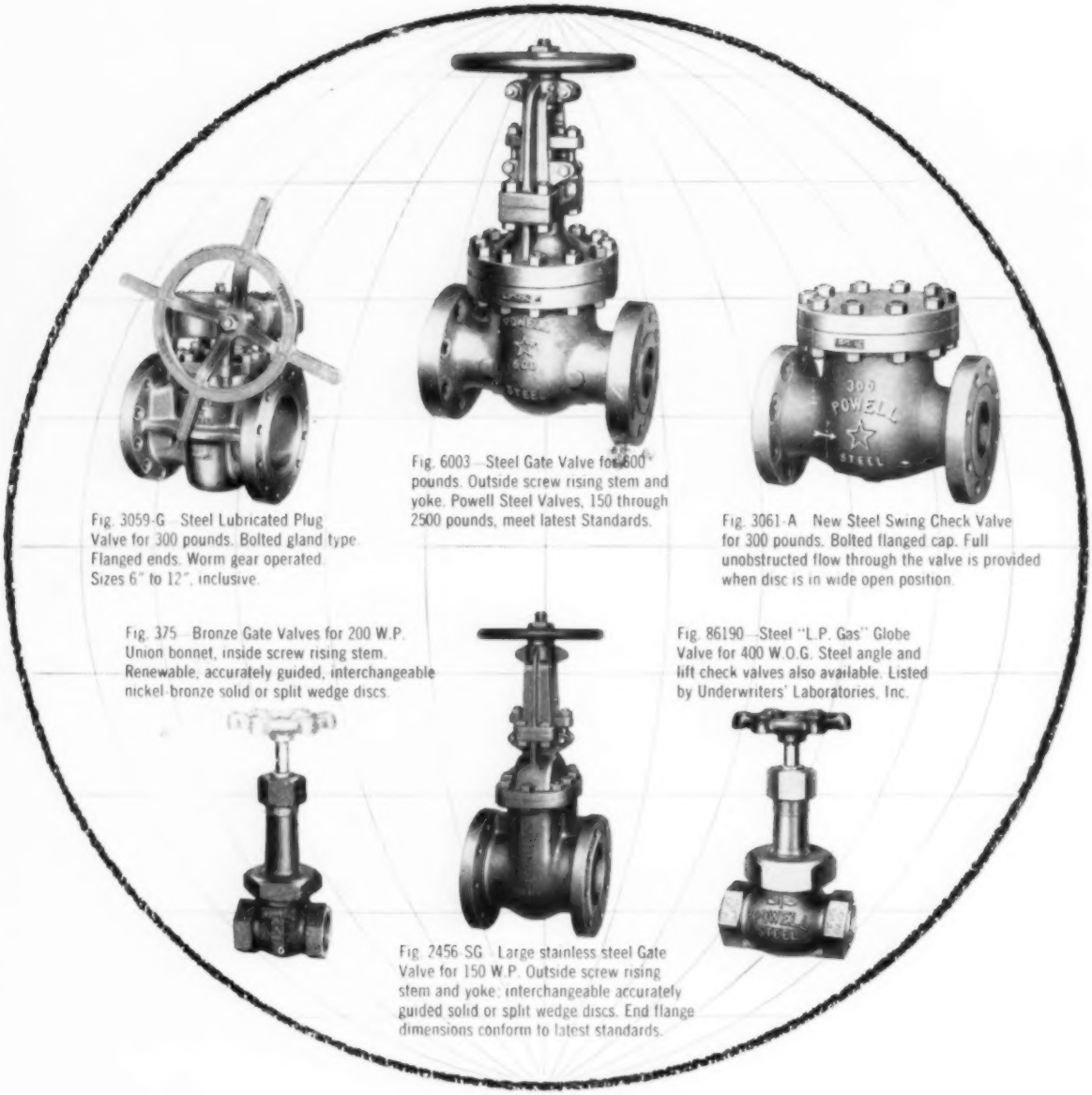

Fig. 3059-G—Steel Lubricated Plug Valve for 300 pounds. Bolted gland type. Flanged ends. Worm gear operated. Sizes 6" to 12", inclusive.

Fig. 6003—Steel Gate Valve for 600 pounds. Outside screw rising stem and yoke. Powell Steel Valves, 150 through 2500 pounds, meet latest Standards.

Fig. 3061-A—New Steel Swing Check Valve for 300 pounds. Bolted flanged cap. Full unobstructed flow through the valve is provided when disc is in wide open position.

Fig. 375—Bronze Gate Valves for 200 W.P. Union bonnet, inside screw rising stem. Renewable, accurately guided, interchangeable nickel-bronze solid or split wedge discs.

Fig. 2456-SG—Large stainless steel Gate Valve for 150 W.P. Outside screw rising stem and yoke; interchangeable accurately guided solid or split wedge discs. End flange dimensions conform to latest standards.

Fig. 86190—Steel "L.P. Gas" Globe Valve for 400 W.O.G. Steel angle and lift check valves also available. Listed by Underwriters' Laboratories, Inc.

A solution for every kind of flow control problem is as near as your local Powell distributor. Powell valves are designed and engineered in the largest variety of metals and alloys, to handle any medium, every flow control requirement. There are Powell distributors in all principal cities. Or, if yours is a special engineering problem, write to:

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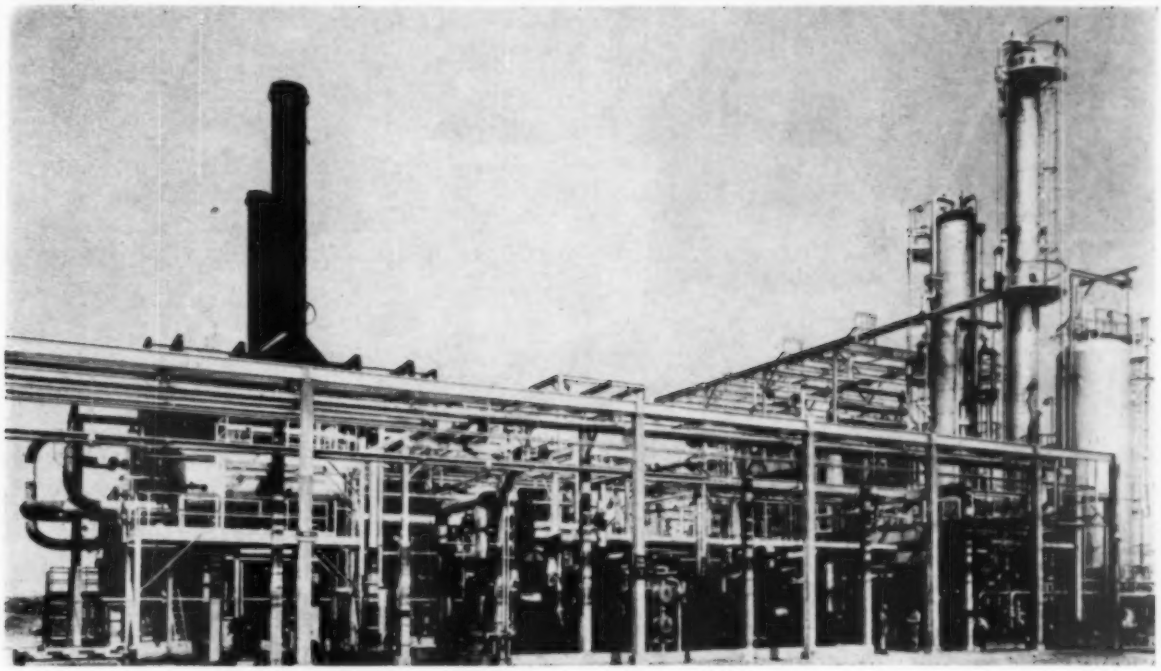
the Refining Engineer

MAINTENANCE AND ENGINEERING ISSUE



Testing this catalytic reformer was made easier using methods described here. Unit, at Frontier Oil Refining Company's Buffalo, New York, refinery, was tested with kerosine during subfreezing temperatures.

This systematic approach saves time and money . . .

How to Pressure Test New Process Units

Kenneth C. Jones and Robert R. Maddocks
Blaw-Knox Company, Chemical Plants Division
Pittsburgh, Pennsylvania

A NEW REFINERY UNIT MUST BE PRESSURE TESTED before it can be put onstream. Primary purpose of this testing is, of course, to be sure the plant is capable of operating safely at design conditions. It is therefore important that testing be thorough and adequate, but not overly time-consuming. A well-planned program can reduce start-up problems and save time and money, as well as ensure plant safety.

A proved method for developing and executing a testing program is given here. These are the six steps involved:

- Determine minimum required test pressures for all involved equipment and piping.
- Combine related equipment and piping with similar test pressures into systems which can be isolated and tested as a whole.
- Mark up mechanical flow diagrams, using a color code, to show systems and pressures to be used.
- Develop general procedures to be used in testing.
- Review overall program with other concerned parties.
- Carry out test in a minimum of time.

Step 1 — Test Pressures

Minimum required test pressure for piping is determined from the latest edition of the Code for Pressure Piping, ASA B31.1, Section 3, "Oil Piping Systems." This minimum test pressure is defined as

$$P_m = 1.5\, P_o \frac{S_{100}}{S_t}$$

where:

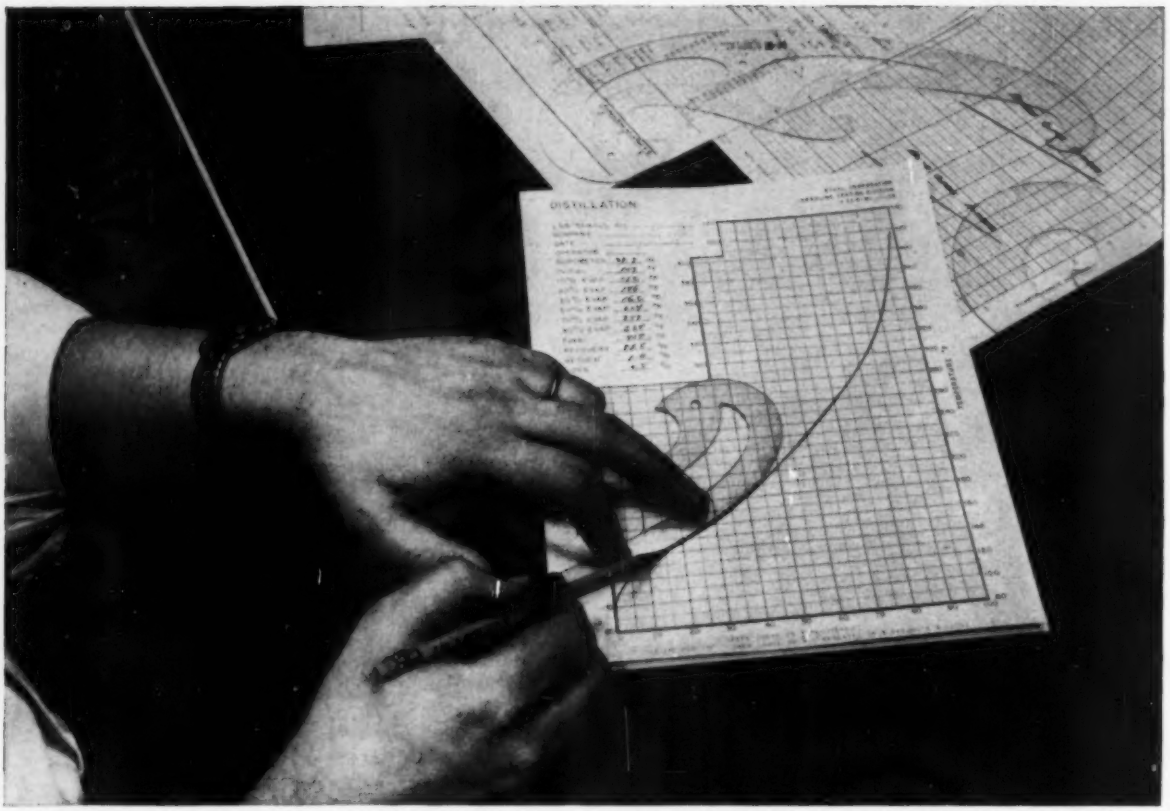
P_m is minimum test pressure in psig;
P_o is operating pressure in psig;
S_{100} is allowable stress for the pipe in question at 100 F;
S_t is allowable stress at the operating temperature.

Allowable stress values are given in tables contained in the ASA Code.

Required test pressure for equipment such as towers, drums, reactors and heat exchangers is usually set at one and one-half times the design pressure of the item.

Step 2 — Testing Systems

After required test pressures for various items of equipment and piping have been determined, the plant should be divided into a minimum number of testing systems. Each system will contain equipment and piping which can be conveniently and safely tested together at the same pressure. A typical test system would be a fractionating tower with its overhead condenser, reflux accumulator, reflux line



Distillation data and octane number data must be tabulated before machine calculations can be made to determine blending properties. Here, data are plotted for fuel blends in various combinations so that intermediate property points can be read.

Ethyl Research Advances the Application of Electronic Computers in Refinery Technology

By Dr. W. C. Healy, Jr.,
Supervisor of the Mathematical Analysis Section,
Refinery Technology Division, Ethyl Research Laboratories

DURING the past three years, the use of electronic digital computers has experienced tremendous growth within the refining industry.

Each new application in this field has been part of an over-all effort to develop the most practical mathematical approach and machine computing technique. Once this is accomplished, the solution of similar complex problems becomes more routine.

A New Section for Computer Study

Ethyl Corporation, the leading manufacturer of tetraethyllead, is vitally concerned with means of achieving most effective use of "Ethyl" antiknock compounds.

Studies of fuel composition, road performance, and octane improvement economics have for many years been a direct result of this philosophy.

Using past experience, the scope of studies by our Detroit Refinery Technology group has been broadened by the formation of a Mathematical Analysis Section to advance electronic computer application.

Field of Investigation

The major technical computer applications which have been studied to date are:

1. Computations of the properties of gasoline blends.
2. Analysis of road test data.
3. Processing of data from tetraethyllead and octane cost surveys.
4. Determination of best allocation of gasoline blending stocks and tetraethyllead.
5. Analysis of refining process operations related to tetraethyllead use; e.g., reforming.

An extensive computer effort has been the determination of best allocation of gasoline blending stocks and tetraethyllead (Item 4), a field of direct interest to those dealing with refinery operation.

Scope and Mathematical Approach

An example refinery running 50,000 barrels crude per day might market several finished grades of gasoline blended from perhaps twice as many refinery streams. A blending problem from this refining situation could consist of as many as 100 equations with perhaps twice as many unknowns.

In the past, this problem of optimizing an operation, while satisfying many restrictions, has been a difficult one and is necessarily limited by the magnitude of computing facilities. However, one form of optimization problem, known as linear programming, can be solved by repetitive simple arithmetic operations.

The basic process is known as the simplex method.

Large-scale, high-speed computing machinery has made linear programming an attractive means of arriving at the best solution of blending problems, even though linear approximations to some blending calculations are necessary.

A requirement of this method is the availability of constant blending values.

One approach to determine good blending values is to use the technique of least squares with component percentages as independent variables. For each property, e.g., Motor Octane Number @ 3.0 ml. TEL-gallon, an equation is determined by least squares as follows:

$$Y = X_1 B_1 + X_2 B_2 \ldots\ldots\ldots + X_n B_n$$

where:

Y = value of blend property
$X_1, X_2 \ldots X_n$ are component proportions by volume
$B_1, B_2 \ldots B_n$ are blending values being determined

Stepwise Solution of the Blending Problem

The usual first step in a computer blending study to optimize blending economics is to perform a series of laboratory blending tests. Such tests provide data for computation of blend properties and also verify computed properties.

These specifications or blend properties then can be expressed mathematically:

Reid Vapor Pressure

Volatility (specified by Distillation)

Research Octane Number

Motor Octane Number

Material Balance

Since the final objective is to achieve maximum dollar profit from the blending operation, economic features must be mathematically expressed as part of the total problem. A minimum list of economic factors ordinarily considered and incorporated in the study are:

Tetraethyllead

Alternate use values for components with more than one disposition

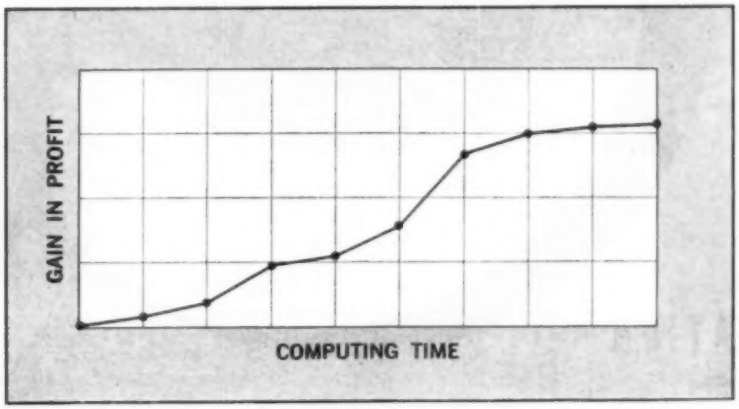
"Net Back" values on products which can vary in quantity.

After equations have been formulated, extensive tabulation is necessary to record equation coefficients on computer data sheets. Following this, all data are key punched on computer cards.

Proofreading is continuous, since a single incorrect sign or coefficient can throw off the whole computation.

Once data preparation and card punching are complete, cases of increasing profit to the refiner are generated on a large, high-speed computer. A study might entail generation of several hundred solutions.

Final solutions are analyzed and interpreted. A few of the better solutions are checked with actual laboratory blends. Following this, the end results are reviewed by process engineers for application to refinery blending.



Ordinarily computer time is used until further increase in profit is negligible. Shown above is a sample plot of gain in profit vs. computer time.

How Ethyl Research is helping you

The formation of a Mathematical Analysis Section in Ethyl's Refinery Technology Division is another step toward most effective use of "Ethyl" antiknock compounds by the oil industry.

This new group of specialists will be glad to share its experience in computation techniques with your people.

For further information, call your Ethyl Representative. He will be glad to arrange an appointment for you with one of our Refinery Technologists.

•

ETHYL CORPORATION
New York 17, N. Y.

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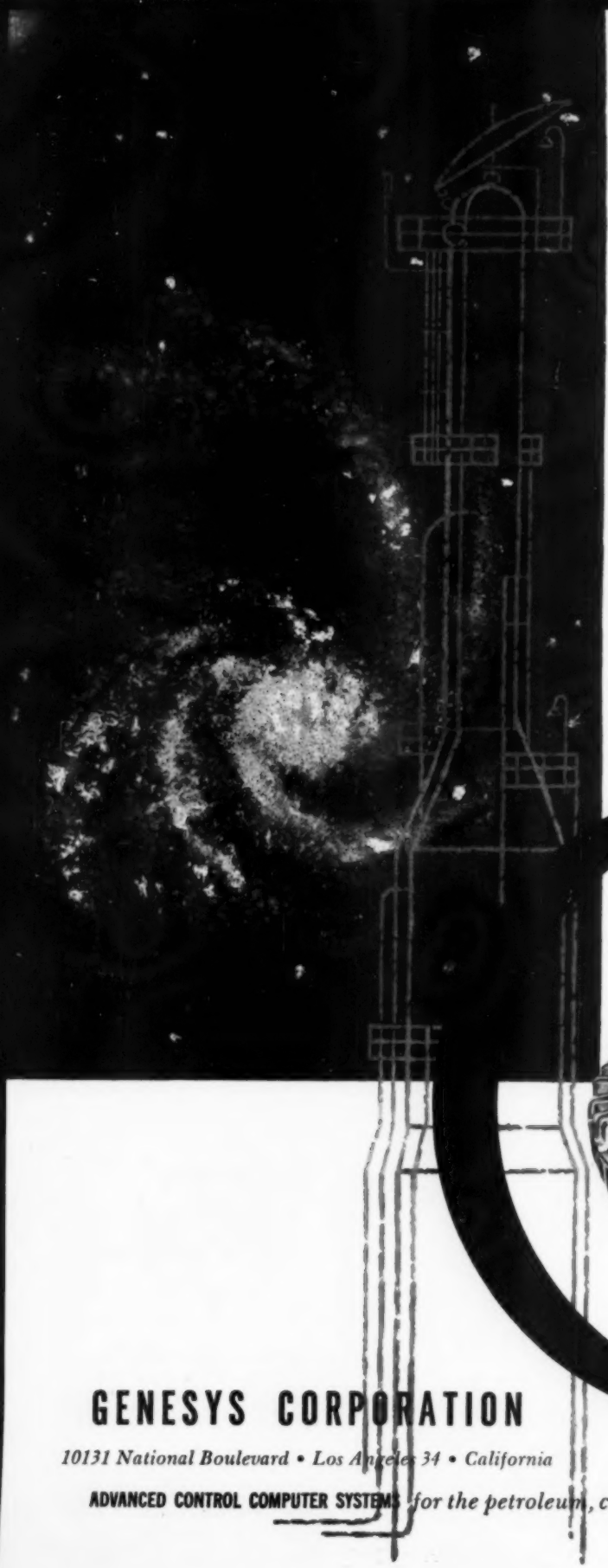

Genesis of a GENESYS System

This Dynamic Memory Processor is a nucleus product creation of the Genesys Corporation. No product has ever approached all of its performance capabilities. A unique building block of advanced Genesys Systems, it achieves *seven giant steps forward* in economic, reliable process control using a minimum of associated hardware:

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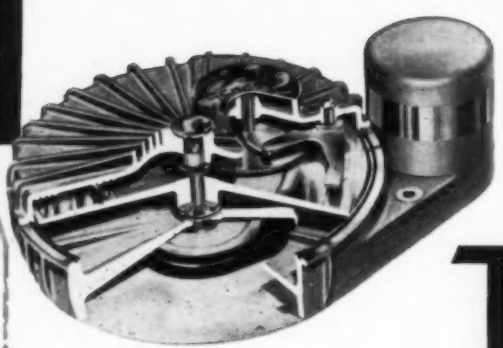
. . . makes correlative decisions

. . . performs extensive computation in the memory

. . . decides on "system optimization" control through learning logic

. . . assumes direct control of actuators and power elements

. . . checks itself automatically for optimum reliability



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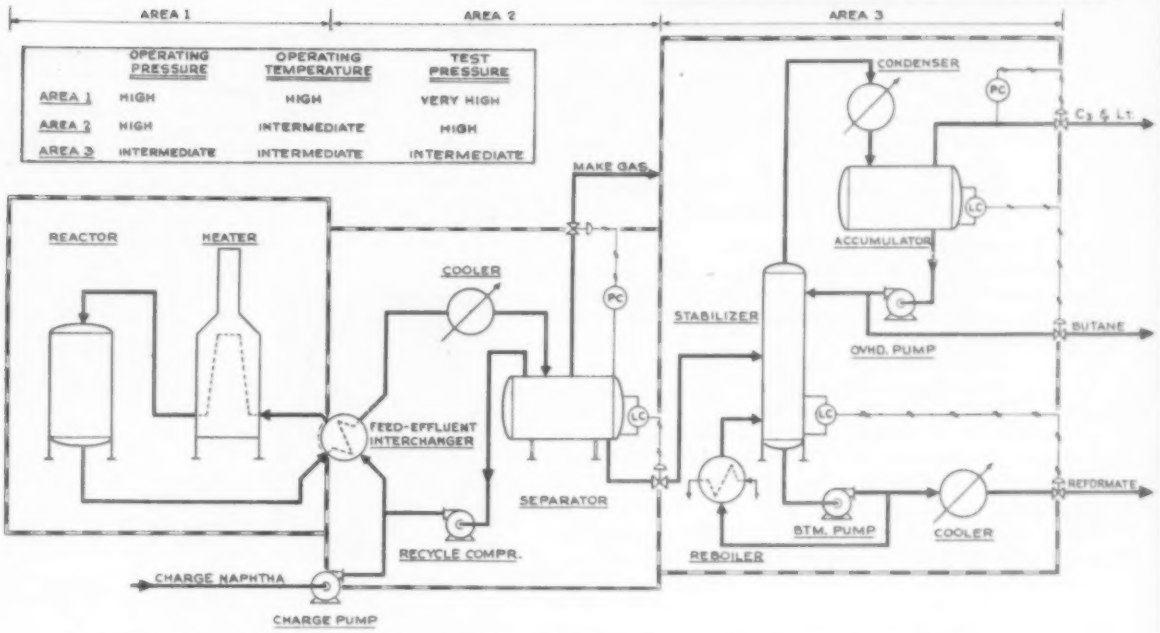


Typical testing systems or zones are illustrated on this simplified flow diagram of a catalytic reformer. It's recommended that in practice color coding be used on the flow diagram as an aid to checking and identification.

and reboiler, along with all associated piping. Another system might be catalytic reformer reactors, plus fired preheater and reheaters, connected heat exchangers and associated piping.

There are two major advantages to be gained by use of such test systems or zones:

1. Insofar as possible the plant is tested in the same condition in which it will be operated. Necessity of installing temporary blanks in the lines to segregate testing areas is kept to a minimum. By this means, number of untested joints is reduced.
2. By eliminating unnecessary work in blanking off lines, time required for testing is reduced.

In developing the systems and pressures to be used, two important points should be remembered. First, test pressures calculated for the piping are minimum values and higher test pressures may be used, if required, to fit into the overall system. Second, equipment is usually shop-tested by the fabricator; his guarantee will be invalidated if the item is tested at a higher test pressure than he used. Test pressure used for a system is, therefore, almost always dictated by the equipment involved and not the piping.

Step 3 — Color-Coded Flow Diagrams

Marking up and color-coding flow diagrams may seem to be an unnecessary step. Actually, indicating test systems and pressures to be used by color on flow diagrams will aid in three ways:

1. In marking flow sheets, the engineer who developed the test will more likely uncover discrepancies in the proposed program. Coded flow diagrams thus provide an excellent means of review and checking.
2. People responsible for program approval will find diagrams a real help in understanding the proposed plan quickly.
3. Having the whole testing program simplified on easy-to-use diagrams is of great aid in the field. As tests are completed and approved, they can be checked off on flow sheets, thus giving an up-to-date record on testing progress.

Having the test systems defined on color-coded flow diagrams will be found useful, even after original pressure testing is completed, for retesting systems that have been repaired, modified, etc.

Step 4 — General Procedures

Techniques to be used in performing tests must next be considered. Most common manner of testing is with water. In cases where water cannot be put into the equipment, some other liquid or a dry gas must be used. Air is often used at pressures up to 100 psig.

ASA Code for Pressure Piping gives recommendations on safe performance of pressure tests. The following procedure for testing is partly extracted from the ASA Code and is presented as an example of those items to be considered in formulating this part of the testing program:

1. A hydrostatic test using water is the preferrable testing technique; however, auxiliary lines . . . steam tracing, fuel oil, etc. . . . may be given an air test. In performing an air test, all flanges will be covered with masking tape with a small hole punched in the tape. All welds, fittings, and flanges will be checked for leaks with a soap solution.
2. Instruments which could be damaged at the test pressure will be isolated from the system. Special attention will be given to pressure gages.
3. Air will be completely displaced from lines and equipment by water when hydrostatically testing.
4. Pumps and compressors will not be subjected to the line pressure test unless so indicated on marked-up flow diagrams.
5. Welds and mechanical joints will not be insulated or otherwise covered during the test.
6. Orifice plates will not be installed for duration of the test.
7. Pressure relief valves will be rechecked prior to installation to insure proper relieving pressure. Blinds will be inserted at installation between relief valve and process line to keep relief valve from popping during pressure testing the equip-

ment. These blinds will be removed upon completion of the test.

8. Control valves will be in open position while testing.
9. Lines supported by spring hangers will be blocked up temporarily to support line weight plus water, where required.
10. Rather than relying on block valves, lines going off battery limits will be blinded.

Step 5 — Review of the Program

Approval of proposed testing program is the next step. You'll want to check your plans with safety personnel plant inspection people and management. They will have three basic questions:

1. Will the test be safe?
2. Will the test be adequate?
3. Will the test be economical?

By means of the color-coded flow diagram and the list of general procedures to be used, the soundness of the program can quickly be shown.

Step 6 — Performing the Test

Tests may be conducted either as the various systems are completed, thereby stretching them out over an extended period, or may all be conducted when entire plant is ready for testing. Advantages of performing all or nearly all of the tests together are that constant supervision is more practical, equipment involved is tied up for a minimum of time and men working on the tests become familiar with techniques being used. As a result of the foregoing, less time and money are expended on the tests.

Basic disadvantage of testing this way is that weld and mechanical joints should be left uninsulated so that leaks can be detected. Waiting until all test systems are complete before testing may, therefore, hold up work of the insulators. Other crafts, such as pipefitters and boilermakers, are required during testing, but there should not be any problem having these people available if the program is well-planned and can start during completion of the last system.

Handling Unusual Testing Situations

By using techniques just presented, even unusual testing situations can be handled without difficulty. This was proved during winter of 1956-57 in pressure testing a new catalytic reforming unit built for the Frontier Oil Refining Company, a division of Ashland Oil & Refining Company, at their Buffalo, New York, refinery. Subfreezing temperatures precluded use of water as a testing medium. Four possible alternatives were considered:

1. Nitrogen,
2. Non-freezing brine solution,
3. Non-freezing methanol solution,
4. Kerosine.

Nitrogen was eliminated as being too hazardous under the high test pressures required. Brine solution was not usable because of danger of subsequent catalyst poisoning from sodium or calcium ions. The methanol solution seemed feasible, but presented problems in reclaiming and/or selling methanol used in the test. It was decided, therefore, to use kerosine.

It was recognized that potential safety hazards were involved in using kerosine. Certain precautionary steps were therefore taken:

1. To minimize handling of kerosine, the unit was divided into as few test systems as possible, and filling done through the pump-out system.
2. To avoid excess kerosine spilling, leaking and possibly pumping into the wrong equipment or lines, a preliminary air test was made of each system before admitting kerosine. This test was to insure that all valves and plugs were properly set and to discover any large flange leaks. Air leakage was found by observing pressure gages and by listening for leaks.
3. To safely do hot work on pinhole leaks found in welds on lines which had been tested with kerosine, two rules were enforced:
   a. The line to be welded upon had to be full of kerosine above welding point so that welding would not be done on a line containing hydrocarbon vapor;
   b. The line had to be vented at a high point to prevent possibility of having test pressure on the line during welding.
4. To overcome difficulties from contraction due to pumping hot kerosine into cold equipment, kerosine was either allowed to cool before proceeding with the test, or pressure loss due to contraction was taken into account. When possible, of course, kerosine was supplied from cold storage.

By observing these precautions, test was conducted with little difficulty and in a minimum of time.

Conclusion

The foregoing case is only one instance of a number of new installations which have been successfully and economically pressure tested using the general approach given in this article. By using the techniques yourself, you can make your next pressure testing program a less painful and more profitable experience. ★ ★ ★

About the Authors . . .

Robert R. Maddocks is manager of The Petroleum and Petrochemical Department of Blaw-Knox Company's Chemical Plants Division, Pittsburgh, Pennsylvania.

Bob holds both bachelor's and master's degrees in chemical engineering, receiving the first from University of Pittsburgh in 1940. He completed his graduate work at Case Institute of Technology in 1951. First employed as a process engineer and operating foreman at Pennzoil Company in 1940, he joined Arthur G. McKee & Company in 1942 and worked there as piping squad leader and later as a senior process engineer until 1951. He served two years as a naval officer during WW II. He was technical advisor for Petro-Chem Development Company during 1951-52, primarily working on direct-fired heater development and evaluation. During 1952-53 Maddocks was a project manager for Bechtel Corporation's New York office, responsible for scheduling engineering manpower, preparation of proposals, and process unit construction and revamps.

In his present capacity Maddocks is responsible for all of the Petroleum and Petrochemical Department's activities . . . plant design, processes, proposals, contracts and sales.

Kenneth C. Jones is a process engineer with the Chemical Plants Division of Blaw-Knox Company, Pittsburgh, Pennsylvania.

After graduating from Grove City College in 1951 with a BS degree in chemical engineering, Ken joined Esso Standard Oil Company. During the next 4½ years he was with Esso's East Coast Technical Service Division, concentrating mainly on prediction of optimum refinery operations, problems of gasoline blending, and selection and economic justification of new process equipment.

Early in 1956 he assumed his current position with the Blaw-Knox Company. His activities since then have included design and subsequent pre-startup testing of various process units. He has served as Blaw-Knox's field engineer during the pre-startup testing of several new plants and is particularly well acquainted with the problems and difficulties encountered in the pressure testing of new units.

INSPECTION AND PREVENTIVE MAINTENANCE . . . KEY TO MAINTENANCE COST REDUCTION

E. A. Hudgens,
Supervisor-Inspection & Preventive Maintenance
D-X Sunray Oil Company, Tulsa, Oklahoma

MAINTENANCE COST REDUCTION is a problem confronting many companies. This cost reduction must be accomplished to meet the ever increasing pressure of competition. It is being attempted by:

- Cutting inventories and associated taxes.
- Planning maintenance and scheduling manpower.
- Inspection and preventive maintenance.

There have been many articles concerning each of these methods individually. It is the intent to point out here how all three are tied together and when combined, how they can affect desired results.

The following is a brief description of what an equipment inspector is, what he inspects and what is done with the information he obtains.

Responsibilities of an equipment inspector. An inspector is principally interested in process and pumping equipment, and storage tanks.

A competent inspector must have a working knowledge of these types of equipment, together with a general working knowledge of chemistry, mechanical engineering and petroleum processes. This knowledge must be combined with the ability to reason logically and to use good common sense.

With these qualifications the inspector can — by using various pieces of testing apparatus — determine condition of equipment so that it can be repaired or replaced. This eliminates costly emergency shutdowns and repairs.

He can then record this condition and the repairs made and place it in a permanent file. After a series of such inspections a rate of corrosion, erosion and mechanical wear can be established. This will permit the inspector to establish a life expectancy for equipment and predetermine the time when repairs or replacement will be needed. At the same time the inspector, in cooperation with the process, mechanical and corrosion engineers, can recommend alloys which economically prolong the service life of equipment.

Equipment Records —key to planning and scheduling. With good records of equipment condition, efficient planning and scheduling can be accomplished. Known condition permits good planning of turnarounds and general maintenance. When maintenance is planned manpower can be scheduled so that maximum results may be obtained with a minimum of man hours spent. Planned maintenance also tends to stabilize the maintenance force.

Work is scheduled so that all crafts-

TYPICAL INSPECTION REPORT AND EQUIPMENT RECORD SHEET

INSPECTION REPORT
SHELL AND TUBE EQUIPMENT CONDITION
EQUIPMENT INSPECTION SECTION

IE 2155

SUBJECT: C-6 Reactor Effluent Feed Exchanger — PLANT: West Tulsa
LOCATION: #1 Platforming Unit — DEPT.: Refinery
FILE REF.: 74-58 — DATE: 6-17-58

MFG. SERIAL NO. — VESSEL NO. C-6

CONDITION OF SHELL SIDE: Minor corrosion--slight scale

SHELL PLATE	Minor Pitting	WEIR PLATE	None
RIVETS OR WELD	Welded. Satis.	TUBE BUNDLE GUIDES	None
SHELL COVER PLATE	Satis.	NOZZLES	Satis.
RIVETS OR WELD	Satis.	LINING	None

CONDITION OF TUBE SIDE: Comparativley clean

TUBES	Satis. thin scale		
FLOATING HEAD	Expan. Jt. cracked	BAFFLES-CIRCUMFERENTIAL	satis.
FLTG. TUBE SHEET	Slight corrosion	BAFFLES-LONGITUDINAL	none
CHANNEL	Satis. annoded	TUBE SPACER PLATES	Satis.
TUBELTS	Satis.	TUBE SHEET SPACER RODS	Satis.
STAT. TUBE SHEET	Slight corrosion	FLOATING HEAD BOLTS	Satis.
CHANNEL HEAD	Satis.	FLOATING HEAD STAYBOLTS	Satis.

RECOMMENDATIONS AS A RESULT OF THIS INSPECTION

A new expansion joint should be installed

REPAIRS EFFECTED

New expansion joint installed. Tubes tested hydrostatically at 100 psig. Special test satisfactorily applied to shell.

FOOTNOTE: SHELL SIDE Naphtha — TUBE SIDE Charge Stock

SHELL AND TUBE EQUIPMENT
GOVERNING PRESSURE: Shell Side 500 PSI at 650 °F.; Tube Side 400 PSI at 400 °F.

PART OF EQUIPMENT	Actual Thick. West	Actual Thick. Pres.	Lin. In.	Corr. Allo	Corrosion Rate From	Corrosion Rate To	Corrosion Rate In/Yr	Est. Life	REMARKS
SHELL COVER	2.00	1.980		.125	1957	1958	20	5 Yr.	Slight Pitting
		1.875							
Mat. 4-6% Cr. Stl.									
FLOATING HEAD	2.00	1.98		.125	1957	1958	20	5 Yr.	
		1.875							
Mat. 4-6% Cr. Stl.									
FLTG TUBE SHEET	2.5	2.48		.125	1957	1958	20	5 Yr.	Slight corrosion on back side.
		2.375							
Mat. 4-6% Cr. Stl.									
SHELL	2"	1.98		.125	1957	1958	20	5 Yr.	Slight Pitting
		1.875							
Mat. 4-6% Cr. Stl.									
STAT. TUBE SHEET	2.5	2.48		.125	1957	1958	20	5 Yr.	Corrosion on back side.
		2.375							
Mat. 4-6% Cr. Stl.									
SHELL SECTION	2"	2"		.125	1957	1958	0	Indef	Noseles Satis.
		1.875							
Mat. 4-6% Cr. Stl.									
CHANNEL HEAD	2.5	2.5		.125	1957	1958	0	Indef	
		2.375							
Mat. 4-6% Cr. Stl.									

TUBE BUNDLE NO.	C-6
NO. OF TUBES	572
NOMINAL TUBE O.D.	.750
GAUGE	14
EFFECTIVE TUBE LENGTH	14' 6"
MATERIAL	4-6% Chrome
TUBE PITCH	Square

INSPECTORS INIT & DAT

All measurements in Knox unless noted.

IE 2155

men will be busy at productive labor, but will never be unduly rushed. Not only will a better quality of work be done but the need of hiring and laying off will be greatly reduced or eliminated. A savings in unemployment compensation tax and a boost in the morale of the employees would result.

Finally, employees with a high morale who are not rushed in their work tend to perform in a safe manner, thus reducing number of accidents which increase insurance rates.

Maintenance forces not used correctly. It has been my observation that most companies have not had a maintenance force, but have had what is actually an emergency crew.

They scurry from one emergency breakdown to another making "get by" repairs because lack of time and spare parts does not permit proper repairs to be made. A piece of equipment in a process cycle is like a link in a chain. The chain always breaks at the weakest link at the time of greatest load. In a process cycle this creates a costly emergency shutdown. Good inspection and preventive maintenance brings these weak links to light before they break and repairs can be made when there is no load on the chain.

Maintain correct stock inventory. Policy in the past has been to maintain a storeroom with a large inventory of spare parts on hand so that "get by" repairs could be held to a minimum. Only those parts which were readily available at a local supply house were not carried in stock.

Good inspection and preventive maintenance, combined with good planning and scheduling based on accurate records of condition, would permit any company to know in advance when spare parts will be needed. In this manner inventories can be cut down and parts can be ordered only far enough in advance to be on hand when needed.

Need cooperation of all departments. It is possible to materially reduce the cost of maintenance by inspection and preventive maintenance combined with planning and scheduling, but it is something which can not be done — especially in an old plant — without the full cooperation of all departments in the company over a period of several years.

* * *

HOW TO ENGINEER A CHEMICAL CLEANING PROGRAM

Ray E. Tschupp
Petroleum Service Division
Oakite Products, Inc., New York, New York

TAKE A UNIT off stream, clean it, have it ready for inspection within 24 to 48 hours. You can do it — if you engineer your chemical cleaning program.

Planning the Program

Cleaning is a major item on the agenda of turnaround planning meetings. The planning group includes personnel from the processing, engineering, and mechanical departments, and frequently a representative from the chemicals supplier.

From this meeting, and those which may follow, a complete cleaning schedule is drawn up. Copies are sent to each department, or excerpts with instructions bearing on their part in the program. The schedules most frequently include a schematic drawing, showing the flow of the circulating solution through the units.

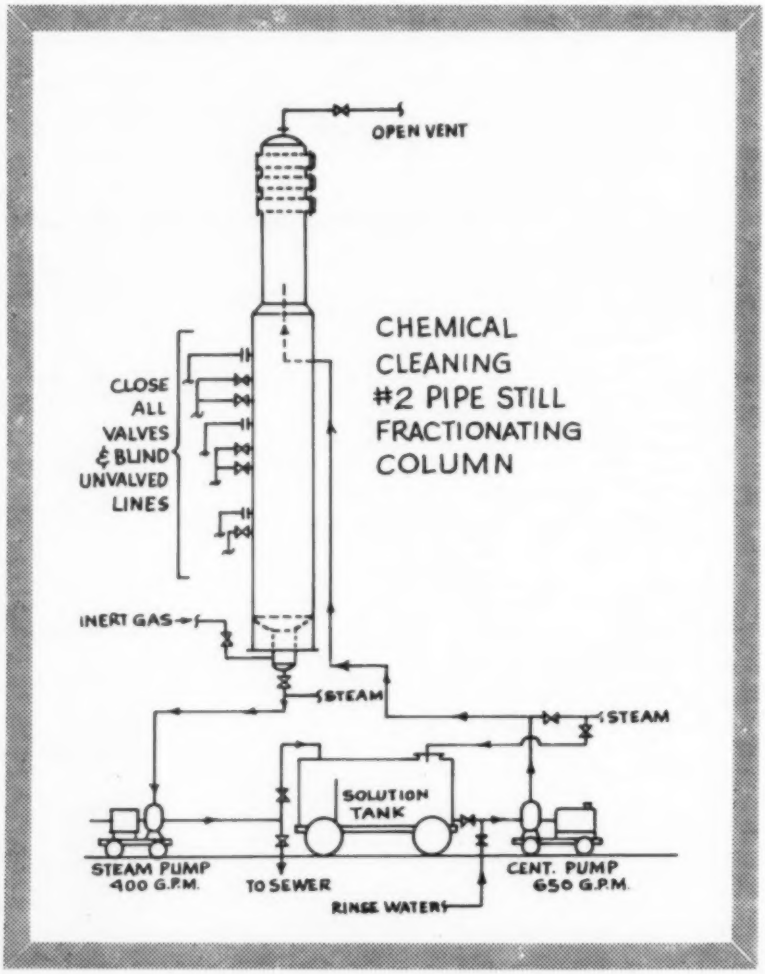
Procedure Used

Here is a typical instruction sheet, together with a sketch of the hook-up used in cleaning a crude fractionating column:

Chemical Cleaning — No. 2 Pipe Still

A. *Column to be cleaned*
   1. Fractionating Column 13′—2½″ Diam × 89′—9″, 23 trays.

B. *Equipment and piping connections*
   1. See attached sketch for piping arrangement.



2. Gasoline engine driven centrifugal pump.
3. 400-500 gal per min steam reciprocating pump.
4. Wagon (3600 gal capacity).

C. *Cleaning solution*
1. Empty wagon and clean out.
2. Fill with water to within one foot of tank top.
3. Add cleaning solution or compound.
4. Use steam lance to mix thoroughly and heat.
5. Above solution is concentrated to permit dilution with liquid holdback on trays (an estimated total volume of 3900 gal will be required).
Note: Supplier representative or technical service engineer will be available for titrating solution to maintain proper strength.

D. *Cleaning Procedure*
1. Check sketch to make certain all connections are properly made.
2. Line up valves to permit taking suction from solution tank with centrifugal pump and discharging through 6-in. line to top of column (see sketch).
3. Line up suction and discharge valves in lines to and from 400 gal per min steam pump returning cleaning solution to its tank.
4. Circulate 400-500 gal per min hot solution through column back to tank, a total of 12 hours.
5. Pump all solution to tank and an acid cleaning tank.
   a. Adjust pumping rates to avoid losing suction with either pump.
   b. Cut sufficient steam into discharge line of centrifugal pump to raise temperature of solution to 210 F.
   c. When return flow has been established cut steam into column to maintain solution temperature. Also, purge inert gas through column periodically (5 to 10 minutes during each hour of washing).
6. Water wash with sufficient volume fire line water to flood trays. Wash water will go to surface drain. Procedure for water washing will be the same as for washing except:
   a. Steam will be cut into pump discharge line to top of column during the early part of water wash.
   b. Steam will also be cut into bottom of column during this time.
   c. As soon as water stream clears shut steam off and wash with cold water.
   d. Discontinue washing when water reaches a pH 7-8 and steam clears.

E. *Precautions*
1. Wear goggles and rubber gloves when mixing and handling solution. Solution is strongly alkaline.
2. Gas test at tank manway periodically during early part of circulation.
3. Use caution signs and inform people working in area that chemical cleaning is in progress.
4. Tag valves where required.

Instruction Is Important

From the foregoing it is easy to see the importance of familiarizing all departments with the proposed cleaning plans; in fact, to have all departments represented when making plans for a turnaround.

Estimating steam requirements, pipe fitter and rigger time, availability of chemicals required, number of laborers needed to handle chemicals, etc., and scheduling for optimum work output, eliminates costly delays.

A review meeting, a few days before bringing down the unit, is wise, as it often leads to clarification of minor details which might upset the otherwise well-planned turnaround schedule.

Selection of Cleaning Agents

Chemical cleaning, as mentioned before, means more than mere acidizing. Products designed for petroleum cleaning today are complex blends of acids, solvents and wetting agents, or alkalis and soaps with solvents and chelating agents.

Cleaning compounds are designed to remove specific soils with speed and efficiency, no one cleaning compound will, therefore, do all jobs equally well.

Selection of the cleaning material will depend primarily upon these factors:

1. Charge stock.
2. Type crude.
3. Operating temperatures.
4. Time on stream.
5. Type of metal.

Other factors, such as the use of corrosion inhibitors and water treatment materials during processing operations, will influence the material selection, but they are of secondary importance.

Equipment

No matter how carefully or precisely designed the material may be, it requires the right kind and amount of mechanical action to do its job, efficiently. Pumps must have adequate pressure; circulation must be maintained according to the compound manufacturer's recommendations. Heating facilities must be adequate to develop and sustain the required temperatures. Rinsing, which floats off the insolubles removed by the cleaning action and flushes out the cleaning solution, should have sufficient pressure, agitation and time to do its very important work. ★ ★ ★

POLYETHYLENE REDUCES PLANT CORROSION

LOW PRESSURE, high density polyethylene is coming into increasing use for fighting corrosion in process plants. Phillips Chemical Company, for example, has installed 2-in. electrical conduit made from Marlex®, their new low pressure, high density polyethylene.

The conduit was installed in August 1957 in the company's ammonium sulfate plants on the Houston Ship Channel at Pasadena, Texas. Whereas life of the galvanized steel previously used was about one year in the sulfate dust and salt water atmosphere, the polyethylene tubing installed in highly acid areas such as beneath the platform on the crystallizer structure, the fines dissolving area and the ship loading areas has eliminated the corrosion problem.

Phillips says that cost of the polyethylene tubing, purchased from a commercial supplier, was 45 percent less than galvanized steel. Installation was quite easy, with joints fused in less than a minute by heating ends and fitting with hand pressure.

Polyethylene conduit was also recently installed in the cooling tower of Phillips Petroleum's Kansas City refinery. The company says that it plans to use the polyethylene conduit for all of its replacement work. Other applications programmed or in use by Phillips and its Phillips Chemical Company subsidiary include rope, hoppers, trash barrels, piping cooling tower fill and instrument housings. ★ ★ ★

HAVE YOU TRIED TITANIUM TO CHECK CORROSION?

TITANIUM is getting increasing attention in process industries as a means of solving certain critical corrosion problems. Abstracted here is a full report on titanium in process plant applications — present and future — presented at the 50th Anniversary Meeting of the AIChE in Philadelphia, by Leo J. Barron, Specialty Products Section, E. I. duPont de Nemours & Company.

Most present process applications are based on corrosion resistance. Other properties that have also accounted for some use include resistance to cavitation, low thermal expansion, resistance to sticking and "wetting," and the combination of high-strength-medium modulus.

Corrosion Resistance

Titanium is in some respects similar to that of stainless steel. Titanium forms a thin, tough protective film when exposed to air or most other oxidizing media. Because this film is easily maintained, particularly under oxidizing conditions, titanium displays extraordinary resistance to natural environments and to many strongly corrosive oxidizing chemicals and solutions.

It is readily attacked by hydrochloric and sulfuric acids at even moderate concentrations and temperatures. Despite this, a considerable number of applications have been made in hydrochloric and sulfuric acid service. This is possible because the protective film can be preserved by presence of oxidizing agents in these acids.

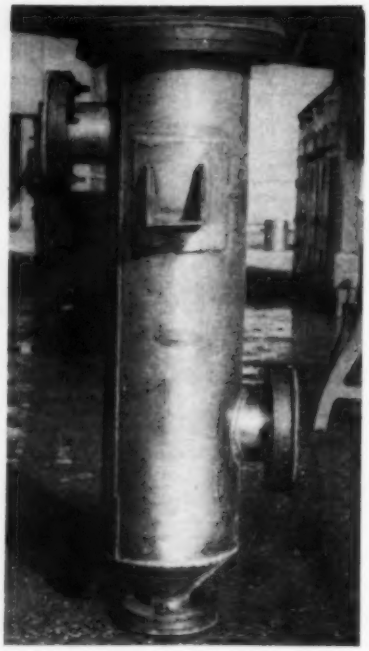
The excellent resistance of titanium to aqua regia is a notable example of attack inhibited by an oxidizing agent.

An outstanding feature of titanium with respect to corrosion is its resistance to inorganic chlorides, wet chlorine and the hypochlorites. Furthermore it does not appear susceptible, in such environments, to stress corrosion cracking or to intergranular attack of the heat affected zone of welds. The only reagent found to promote stress corrosion cracking in titanium is red fuming nitric acid.

Process Applications

Unalloyed titanium rather than titanium-base alloys has proved adequate for most process applications. Its strength levels range from 40 to 70,000 minimum yield, sufficient for chemical equipment. It is readily welded and fabricated, and more is known of its corrosion behavior.

Nitric acid operations represent a growing area of use. In one Du Pont plant a process involving 60 percent nitric acid at 480 F and 300 psi pressure limited the service life of stainless steel condensers to six months. Titanium has extended life of the units to an expected 10 years.



Titanium jet after-condenser operating in an environment of nitric acid, organic acids and brackish water.

When the costs of labor associated with each six-month replacement are combined with actual equipment expenses over the 10-year period, total savings realized by this plant through titanium will amount to an estimated $162,000.

A titanium jet aftercondenser operating in an environment of nitric acid, organic acids and brackish water proved very successful. Stainless units failed in 4 to 6 months here, with failure being due to stress-corrosion cracking, which was probably accelerated by the brackish water.

Several other firms have experienced similar results in nitric acid with titanium. Units presently installed include fabricated piping assemblies in diameters up to four inches, heat exchangers, coils, agitators and a variety of accessories such as thermowells, diptubes, nozzles, fasteners and valve trim.

Because of titanium's immunity to both the corrosion and stress-corrosion effects of hot high-chloride water, the Gulf Coast and other coastal areas represent a growing field of use for the metal. This is because the combination of expanding industry and decreasing fresh water supply is leading to the use of brackish water for process cooling.

The Wyandotte Chemicals Corporation has reported several highly successful applications, including a sodium hypochlorite heat exchanger; a pump impeller and shaft in an organic chloride-hydrochloric acid-wet chlorine solution, and packing supports in a chlorine-caustic tower.

A cost study revealed an annual cost of $39 for the titanium pump impeller compared to $420 for a nickel-chrome-molybdenum impeller.

Because of a comparatively higher heat transfer rate, titanium has been reported as an effective improvement over glass and other non-metallics in sodium hypochlorite cooling installations.

Steam jet diffusers, handling high-pressure steam and dilute hydrochloric acid, represent probably the first industrial use of titanium. In this case, the best previous material lasted 6½ months. Titanium units show no corrosion or erosion effects after nearly 5 years' service.

Cost and Justification

Titanium mill products are priced at $8 to $14 per lb. When titanium's lower density is considered, together with its fabrication expense — which is a little more than for stainless — a finished unit in titanium is only two to four times more expensive than one in stainless.

Titanium is outlasting other materials by factors ranging from 5 to 25. In terms of reduced downtime, maintenance and lost product, economic justification is thus often striking.

Future of Titanium

For the next several years titanium is expected to make a continuing further penetration into present areas of use. Commercial availability of castings, which is now a reality, has opened an entire range of pumps, valves, and similar apparatus to titanium specification.

Another step which will lead to increased industrial use concerns code-approval of titanium for unfired pressure vessels, which is now in progress.

Titanium-clad products, feasible in tanks and vessels, now enable several equipment designs heretofore impractical.

Titanium may some day be as widely used in process service as stainless steel, Barron concluded. ★ ★ ★

Two Maintenance Tips from Cities Service's East Chicago Refinery

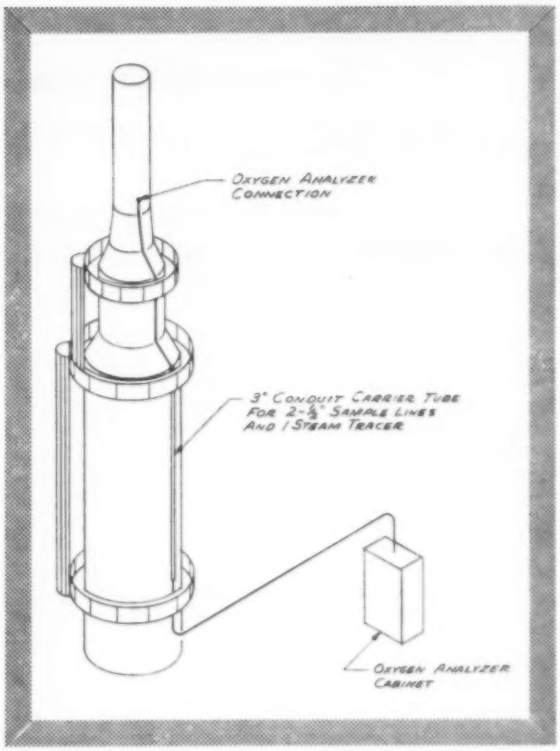
K. L. Mertens
Maintenance Superintendent
Cities Service Oil Company
East Chicago, Illinois

THIS DESIGN CUTS FLUE GAS SAMPLE LINE MAINTENANCE

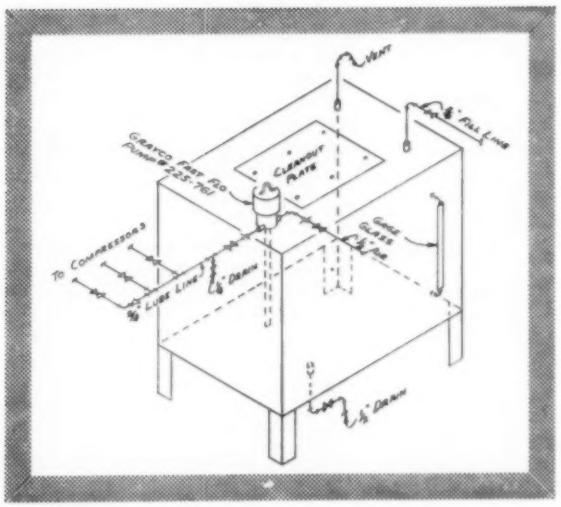
SAMPLE LINES used in analyzing furnace flue gases on tall vertical fired heaters require frequent maintenance, such as unplugging or replacement. Previously, these lines — ½ in. OD tubing — were bracketed together into a bundle along with a steam tracing line. Then they were covered with insulation to maintain the temperature above the freezing point during the winter season. Whenever these lines needed replacement or repair, 60 ft of scaffold had to be erected, insulation removed, and again reinsulated after the repair or replacement was completed.

A sizeable savings was realized when a 3-in. diam carrier tube was mounted on the side of the heater (see sketch), extending from the bottom platform to above the top platform, some 70 ft above grade. The carrier tube is in reality 60 ft of 3 in. threaded conduit coupled together and covered with standard 3 in. pipe insulation. The flue gas sample lines (½ in. OD tubing) and steam tracing line are pushed through the 3 in. conduit and connected by unions above and below the tube to the remainder of the system. In order to make the steam tracing line effective, the tube is sealed with plastic insulation at top and bottom to keep the lines from freezing during the winter season.

Whenever one of the lines needs replacing, that particular line is uncoupled above and below the carrier tube and is pulled out of the tube at the bottom platform. The new replacement line of ½-in. OD tubing is pushed down through the carrier tube from the top platform and recoupled into the system.



SPECIAL DISTRIBUTION SYSTEM IMPROVES COMPRESSOR LUBRICATION EFFICIENCY



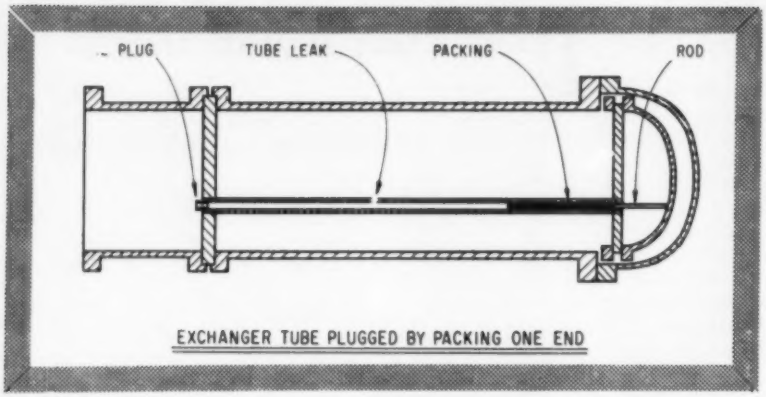
ALL COMPRESSORS, whether used to compress air or gases, need oil added to the reservoir to maintain proper lubrication of the power and compressor sides of the machine. Previous to the tank storage installation, this quantity of oil was handled in five gallon cans, the operator filling the cans from lubesters and carrying them to each compressor where he emptied the cans into the reservoir.

A simple lube oil distribution system was installed at a Fluid Hydroforming unit by setting a 225-gal capacity tank in one corner of the compressor house. An air operated pump is mounted in one corner of the tank. The discharge of this pump was piped to each of the three compressor reservoirs and so manifolded, as shown by the drawing. After the pump is started oil flow is directed to any particular reservoir by proper valve manipulation.

By this method of installation, an operator has only to start the pump at the tank, then go to each compressor where he opens the valve on the lube oil supply line, which allows oil to flow into that particular compressor reservoir.

Auxiliary equipment on the tank consists of a cleanout plate, gage glass, inlet line from the barrel unloading station and a bottom drain valve. The tank is filled from the barrel unloading station through the tank filling line by use of another barrel pump.

QUICKIE METHOD FOR PLUGGING LEAKING HEAT EXCHANGER TUBES



Exchanger tube plugged by packing one end.

Here is a successful method of plugging heat exchanger tubes that Continental Oil Company has used for several years. This method was observed in another refinery by one of Continental's labor foremen while on vacation.

Prior to the use of this new technique, a leaking exchanger tube meant one of two alternatives:

1. Ride it out.
2. Shut the unit down, steam out the equipment, and plug the leaking tube on both ends with a metal plug.

Only the channel cover is removed in this method. If the heat exchange equipment is a condenser, it can usually be plugged without gas freeing. In fact, when there is more than one condenser in series, many tubes can be plugged on the run.

Procedure used is as follows:

Remove the channel head and locate the leaking tube or tubes using a rod about as long as the assembled exchanger. Push it into the leaking tube until it seats firmly against the inside of the floating head. Then mark the rod next to the stationary tube sheet. Remove the rod from the tube.

From the marked length deduct the tube length less the thickness of the floating tube sheet. Cut the rod at this point; shove the short section into the leaking tube until it seats solidly against the floating head.

Insert aluminum or lead foil into the tube, packing it firmly until there is a total foil thickness of approximately 12 in. Use the long section of the rod to tamp the foil. This will permit you to judge the amount of foil in the tube by the position of the original mark.

Remove the long rod and plug the stationary tube sheet end of the tube with a standard metal tube plug. Replace the shell cover, and you are back in business.

The sketch shows how an exchanger tube will look after it has been plugged.

It has been found that in most instances this entire procedure requires approximately 30 minutes. If the leak is not too severe, the work can be performed on condensers while the unit is in operation.

Choice of aluminum or lead foil should be made on the basis of the temperature and composition of the material flowing through the tube. It is not necessary to consider pressure, because it has been found that the packing will withstand more pressure than the tube itself.

One word of caution is that this method will not work if the leak is the result of a split roll.

New Method for Applying Polyethylene Vessel Linings

A "COMMERCIALLY SUCCESSFUL" method for applying polyethylene to steel surfaces as lining material for tanks, pipe and valves has been announced by Tank Lining Corporation, of Pittsburgh, Pennsylvania.

Previous attempts to coat vessels with polyethylene have met only with limited success, according to Tank Linings. They say that flame-spraying systems have managed to "bond" plastic to steel but that the plastic lost many desirable properties and often broke down in use. Dip methods for applying polyethylene have been successful for small pieces, but are impractical for large tanks and vessels.

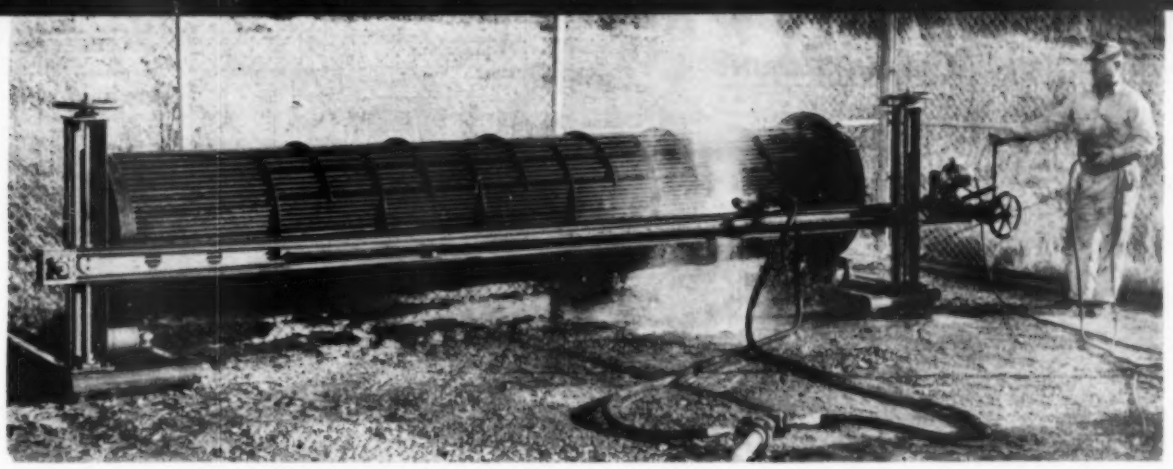
Application technique. The new method involves special preparation of the base steel and spraying on a prepared high molecular weight, high density, low pressure-type polyethylene. This is followed by a carefully controlled heat treating process.

Results obtained. Tests indicate the new application method does not weaken physical properties of the polyethylene, Tank Linings says. Although the polyethylene is specially-prepared, it is not extended, modified or plasticized before use, and it can be pigmented if desired.

Test panels lined with polyethylene have shown excellent resistance to 90 percent sulfuric acid, 83 percent phosphoric acid, alcohols, solvents, and other petroleum-petrochemical products, the company claims. Experimental commercial applications on small tanks, agitators, baffles and pipe have performed well, it's pointed out.

Many uses visualized. Tank Linings says that the chemical-petroleum industry's annual corrosion bill is some $6-billion in terms of product losses and materials of construction. Thus, the company expects polyethylene linings to be quite useful for storage tanks up to 3500 bbl capacity, railroad tank cars, tank trucks, process equipment, duct work, valves, etc.

Other desirable properties claimed are the lining's good electrical insulation properties, flexibility and resiliency. Resistance to abrasion is said to be moderate. Use of polyethylene lining for vessels which must be easily cleaned is desirable, according to Tank Linings' spokesmen, although its resistance to adhesion of foreign materials is not quite as good as for Teflon and silicones.



The hydraulic tube bundle cleaner in action. Bundle rests on flanged rollers that can be adjusted for bundle length and diameter.

HYDRAULIC TOOL TO CLEAN HEAT EXCHANGER BUNDLES

W. M. Zingg
and B. L. Canaday
Dowell Division of The Dow Chemical Company
Tulsa, Oklahoma

A NEW HIGH-PRESSURE hydraulic tool has solved many of the problems encountered in attempting to clean heat exchanger bundles. This new tool removes deposits from bundle tubes by mechanical action of high-velocity water jets.

The new heat exchanger jetting tool was developed to overcome many of the difficulties experienced in cleaning exchanger bundles. It has successfully removed practically every type of deposit except for extremely heavy asphalt deposits, which have not as yet been successfully removed.

Bundle Cleaner

The bundle cleaner shown consists of two bases between which extends a movable beam which supports the hydraulic jetting head. This jet head is mounted on a trolley that is propelled along the supporting channel beam by a motor.

Each of the bundle cleaner's two base units has a pair of flanged rollers on which the bundle being cleaned rests. These rollers permit the bundle to be rotated so that it can be jetted from different directions. The flanged rollers can be positioned at various distances from the jet head to accommodate bundles of different diameters.

In operation, an electric motor moves the trolley-mounted hydraulic jet head back and forth along the beam. The motor also raises or lowers the entire beam assembly either 1¼ or 2½ in. during each round trip of the trolley from one end of the beam to the other. Thus the jet head covers the entire vertical area of the bundle being cleaned. A complete cleaning cycle from top to bottom of a 36-in. bundle requires 16 min. Slightly more than an hour is required to jet a bundle this size four times, rotating it 90 deg between each cleaning pass.

The jet head delivers either 65 gal per min at 3000 psi, or 175 gal per min at 3000 psi, depending upon the pumping equipment employed. The number and size of jet orifices used with the jet head can be selected to provide maximum efficiency for the cleaning service performed. Such selections are governed by the nature of the deposits encountered.

Cleaning Procedure

In cleaning a bundle, the bundle cleaner's rollers are first adjusted for the diameter of the bundle to be cleaned. The bundle is removed from the shell, placed on the rollers, and rotated until the tubes present a horizontal passage for the high-velocity water jets. The beam which supports the jet head is adjusted so that it is parallel to the bundle's tubes, and jetting is begun.

With many bundles, the entire jetting operation can be completed in about an hour and a half. This allows for jetting the entire vertical area of the bundle from four different directions, rotating the bundle 90 deg after each jetting.

Badly fouled bundles may require as many as three or four jetting passes from each direction, in some cases requiring as long as eight hours for cleaning. Further experimental work is now under way on problems of removing heavy asphalt or polymerized deposits. The difficulty in removing asphalt is that, while asphalt is solid enough to resist the impact of high-velocity jets, it is resilient enough to absorb much of the energy of the jet streams. However, in many cases other deposits intermingled with the asphalt provide weak points which allow the water jets to enter and break away asphalt deposits

Case Histories

A bundle 4 ft in diam and 16 ft long was covered with deposits consisting primarily of iron oxides, with some hydrocarbons. One pass or cleaning cycle by the high-pressure jetting tool from each of four directions thoroughly cleaned the bundle. Total jetting time was slightly more than one hour.

Another bundle had deposits of fairly loose dry material. The bundle was 18 in. in diam and 20 ft long. Pitch of the brass tubes was so close that it was impossible to insert a knife blade between them. Therefore it was exceedingly difficult to clean. The high-pressure jetting tool cleaned the bundle so thoroughly that the cleaned tubes were a bright brass color.

A slurry reboiler exchanger bundle, 3 ft in diam and 16 ft long, was fouled with deposits of coke and asphalt. One pass from each of four directions cleaned the bundle thoroughly.

Three rectangular bundles 5 ft high, 1 ft wide, and 16 ft long, were cleaned. The cleaning service was so effective that the refiner commented that these bundles were cleaner than they had been in the past 13 years.

A bundle 3 ft in diam and 16 ft long, fouled with grease deposits, was jetted from four directions, two times in succession. It was completely cleaned except for a few spots of grease splattered by the jet stream.

An eastern refiner had several bundles 3 ft in diam and 16 ft long which were severely fouled with coke and asphalt deposits. The last time the refiner attempted to clean one of these bundles, it was necessary after cleaning efforts, to discard the bundle. One of these bundles was jetted with the bundle cleaner. The refiner had sawed out deposits around the first few rows from one direction. After this bundle was jetted for about eight hours, it was 95 to 98 percent clean. ★ ★ ★

WHAT BASE METAL ARE YOU WELDING?

MAINTENANCE in the refinery brings many diversified welding problems. Under service conditions metals fail in numerous ways. Many times welding is used to repair this damage so that a badly needed plant or machine can be put back in operation.

Ray M. Kolb, head foreman — welding shop, Standard Oil Company (Indiana), states that when such a job arises there are some fundamental questions which need to be answered to assure a successful welding job. One of the most — if not the most — important questions to be answered is what is the base metal to be welded?

It pays big dividends to keep accurate material records of the parts in a plant that may some day require welding. These records can best be obtained when equipment is purchased or built. One must still be careful to avoid ambiguous descriptions such as "stainless steel," "brass," "aluminum," or "alloy steel," as many different types fall into each of these broad classifications.

Practically all of these metals can be welded if their composition is known, but can cause considerable difficulty if a person has to guess what kind of material he is welding.

For example, an occasion might arise requiring a repair weld on a part known only as stainless steel. It could be any one of many types, varying from a readily weldable material like 18 chrome 8 nickel to a difficult to weld, air hardenable material like 12 chrome over 0.15 carbon.

It is a great temptation when materials of unknown composition are encountered to turn the job over to a welder and let him worry about it. However, you will encounter fewer weld failures if you can tell the welder what material he is going to weld, as well as the proper welding procedures and filler material.

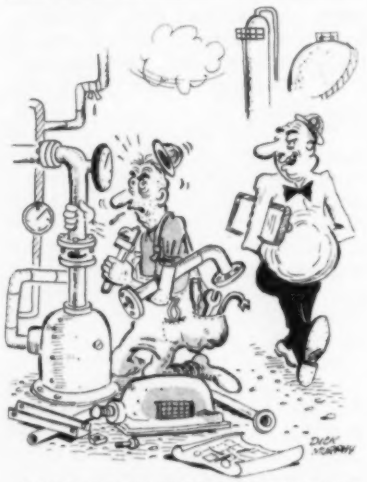
To get an accurate metal identification would require a spectrographic or a quantitative chemical analysis. These analyses are expensive and usually it is not practical to wait long enough for such an analysis to be made. There are a few simple tests, however, that can give you some idea of the metal composition.

Observation of the shape, weight, color and scale or rust formation on a part gives you your first clues as to composition. By the shape of a part it is possible to differentiate between castings, forgings, extrusion, plate, pipe, etc. Since you have a general idea as to what materials are used to make parts of this type, you have an initial start.

Weight allows you to differentiate between the light materials such as aluminum and magnesium and the iron and steel materials. Color characterizes most copper base alloys. Scale and rust formation frequently segregate plain carbon or low alloy steels from the stainless type or the high nickel copper alloys.

Spark testing can often be helpful. Iron base or ferrous materials throw off a characteristic spark stream when held against a grinding wheel, while the non-ferrous materials such as copper, aluminum and nickel-base do not yield any appreciable spark. Testing is best done in a shaded area where the color of the spark stream can easily be seen.

A medium or small grained grinding wheel turning at ordinary operating speeds produces a satisfactory spark. Best results are usually attained by comparing the spark from the unknown material with known samples. Care must be taken to use the same speed and contact pressure since the length of the stream will vary if either is changed. Welding rods are a source of sample material, but care must be taken in using coated electrodes as a comparison metal, since alloying agents are frequently added through the coating. Spark testing charts are included in most handbooks and steel suppliers catalogues.



"LET ME KNOW WHEN YOU'RE ALMOST FINISHED SO I CAN START MAKING CHANGES."

A *magnet* helps us in identification, by separating materials into three groups: (1) Strongly magnetic, such as carbon and low alloy steels; (2) slightly magnetic, such as high nickel alloys and Monel, and (3) non-magnetic, such as copper base alloys and aluminum base alloys.

The magnet test has special significance with stainless steel identification, since the non-magnetic or slightly magnetic materials require no preheat or stress relieving.

A *nitric acid* spot test is another way to get some idea of composition. A drop will not affect stainless steel or stainless iron but will produce a green or blue-green color with Monel or copper nickel and a brown color with low carbon steel.

Chisel testing is frequently used to determine if a part is made of gray cast iron, malleable iron or steel. This identification can readily be made with a sharp-edged chisel and a hammer. By trying to cut a continuous chip — not over 1/16 in. thick — you can tell which of these metals is involved.

With cast iron it is not possible to obtain a continuous chip, as it keeps breaking. In the case of malleable iron a short, slightly curved chip is obtained. It is difficult to obtain chips longer than ½ in. with malleable iron. However, if the piece tested is steel, a continuous curled chip over ½ in. long can be obtained.

It must be emphasized again that the easiest way to know what metal you are welding is to keep accurate records from the time equipment is installed. The foregoing tests give you some idea of how to determine what kind of metal it is, but they do not give an accurate analysis. ★ ★ ★

*Abstracted from the paper "Use of Welding in Maintenance" presented at the 9th Annual Maintenance & Engineering Show, January 27-30, 1958.

FIG. 1. Corroded concrete pump base.

FIG. 2. New concrete pump base protected with saran sheeting.

PLASTICS . . . TO HELP FIGHT CORROSION PROBLEMS

THERE ARE HUNDREDS of plastics materials at the disposal of the corrosion engineer to solve protection problems. Here are just a few of the applications — described fully in a paper presented by H. W. Schmidt, D. R. Gray and J. A. Struthers of The Dow Chemical Company in a paper presented earlier this year at the Annual Conference of the NACE.

Acid Systems

There are many areas in chemical processing where plastics can do a good job of corrosion protection. For example, Fig. 1 shows a concrete pump base which has been eroded and corroded away by the action of water and dilute hydrochloric acid. This deterioration of the concrete had taken place after only two years of service. A similar installation is shown in Fig. 2 after 18 months of service.

As soon as the concrete had set, flexible saran sheet was adhered to the green concrete with a contact adhesive. Lap joints in the sheets were made with a solvent. No deterioration of the concrete or liner was evident and the life of this type of installation is expected to be many times that of unprotected concrete.

This service also produces severe corrosion problems in the piping and pumps employed. Saran lined steel pipe, fittings and pumps complete corrosion protection of such hydrochloric acid handling systems.

Cooling Towers

Another form of corrosion is that encountered in water cooling towers. These installations historically use wood as a construction material for both the shell of the tower and the packing or decks inside. The wide range of water conditions which deteriorate the wood through chemical or biological action remains as a major problem that limits the service life of the unit even though the wood has been chemically treated. This is particularly true of the internal packing.

Packings produced from plastics provide a new approach to this problem.

"I'D LIKE TO KNOW HOW YOU GET THAT MONDAY MORNING PAPER WORK CLEARED AWAY SO QUICKLY!"

Several specific plastic shapes have been developed which are geometrically very different from conventional wood splash decks and film type packings. These shapes take advantage of the physical and fabrication properties of polystyrene, linear polyethylene and saran thermoplastics to obtain excellent performance characterisitcs at reasonable cost.

These packings are completely free from biological attack and deterioration by rot. Polystyrene is suitable for use in many industrial units where the water is free from contamination with aromatics, chlorinated hydrocarbons and ketones. Linear polyethylene and saran packing is recommended for industrial units where these contaminants are present.

Vent Stacks

A glass reinforced polyester vent stack is a good example of the replacement of wood construction at a saving in installed cost and maintenance. For example, the life of a certain wood stack was about eight years, but annual maintenance was required to tighten the stays. A glass reinforced polyester vent stack has given excellent service for two years completely free of maintenance. The installed cost is competitive with wooden stacks.

These examples show how plastics are becoming increasingly important in fighting corrosion. Their moisture resistance and chemical resistance makes them well suited for protection against corrosion. ★ ★ ★

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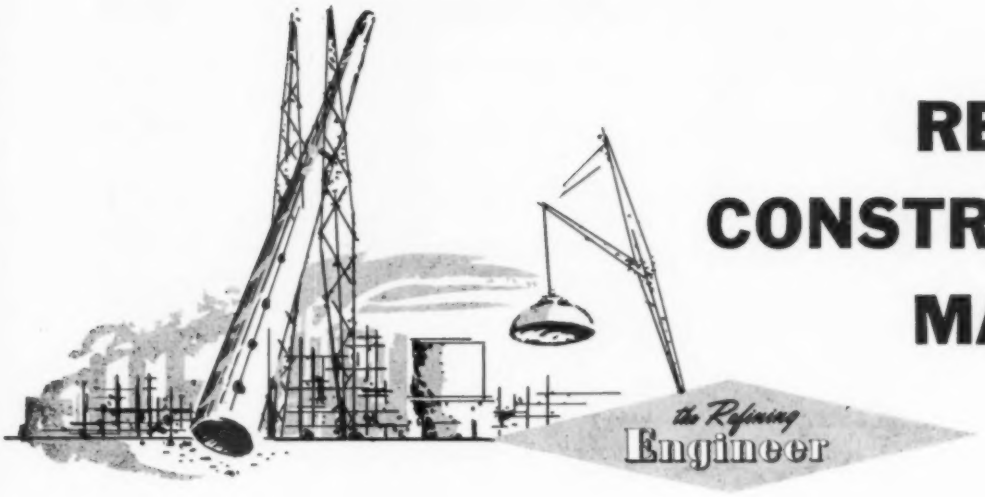


REFINERY CONSTRUCTION MANUAL

Henry Martyn Noel
New Canaan, Connecticut

PART 4: SCHEDULING DESIGN AND CONSTRUCTION

. . . Good Scheduling Saves $$$ and Headaches

SCHEDULING OF DESIGN AND CONSTRUCTION WORK is a key phase of engineering work on new process units. Schedules, covering all aspects of engineering, design, fabrication and construction play an important role in completing a major job with minimum delay and cost. Discussed here are the various types of schedules that must be prepared and typical time allotments.

An overall master schedule, based on the firm cost estimate for the entire project, should be worked out in detail between the scheduling department and the engineering and construction department chiefs involved. This master schedule shows number of hours allotted to each item for design and construction, and indicates the order in which the items are to be handled.

Scheduling Engineering Work

Engineering work must be scheduled as carefully as for the procurement of shop fabricated material and equipment and for field construction. Basis for this scheduling is the original process planning and approximate cost estimates, plus the judicious use of past experience.

The project estimate is already broken down into equipment categories. Using these standard categories and past experience, the scheduler allots hours for engineering work in terms of studies, specifications preparation, requisitions and drafting.

Several techniques are used to determine time required for engineering work. For certain items it is possible to estimate hours as a percentage of estimated cost. As an example, engineering studies and requisitions needed for piping of a process unit is taken as five percent (as hours) of the estimated cost. Thus a $100,000 piping system would require about $100{,}000 \times 0.05 = 5000$ hours to design and issue requisitions. This figure would then be broken down into, say, 1800 hours for process and mechanical design and 3200 hours for drawings and requisitions.

For most items it is possible to assign a standard figure for hours of process and mechanical engineering, and drawings and requisitions. Typical times might be as follows:

	Process & Mechanical	Drawings & Requisitions
Towers	40 hours	70 hours
Drums	7 hours	30 hours
Reactor	100 hours	500 hours

Manpower assignments are then made in accordance with the schedule established. The scheduling doesn't end there. Continual follow-up is required to make certain that work is proceeding on-schedule . . . if not, additional manpower should be assigned. Faltering in the design, drafting or procurement work can cause serious dislocations in activities of all other departments.

Scheduling Field Construction

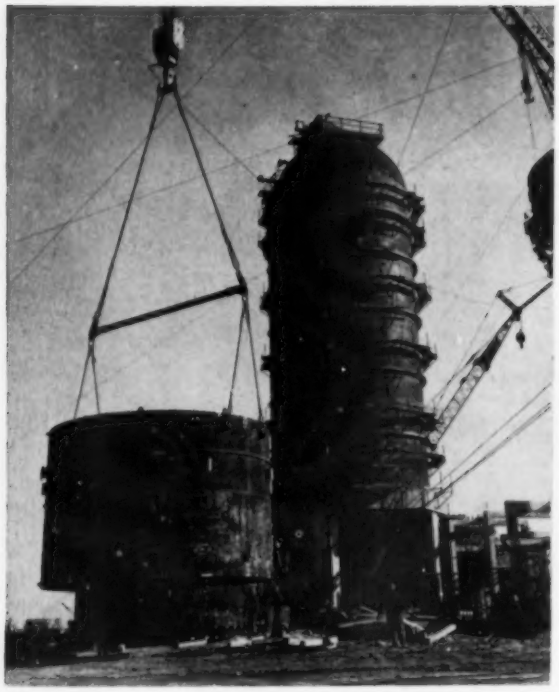
Major key to completing this schedule is assembly of data on lead times — the time needed for shop fabrication and delivery of equipment such as vessels, heat exchangers, furnaces, valves, piping, instrument system components, etc.

Lead time data are available through the procurement division or purchasing agent's office. Typical lead times are difficult to establish since during one period certain valves, for example, may be off-the-shelf items and at another time may be in scarce supply. A vessel fabricator's shop might be open immediately to start on a major vessel, or a three-month delay might be involved.

Scheduling of lead dates for procurement involves back-calculating from the field construction schedule according to first estimate of project completion, with adjustments made in both construction and procurement schedules according to lead time estimates.

Included in the construction schedule is the field superintendent's estimate of time required to secure major construction tools and to assemble his field forces. This is usually done while engineering design work is proceeding.

Time for actual field construction follows a fairly definite pattern, such as in the example table showing time for actual



Piece suspended from derrick not visible in picture is being hoisted into place as part of a fractionating column for Tidewater Associated Oil Company's Orthoflow fluid catalytic cracking unit.

field work in building a large catalytic cracker and an LPG plant.

In these examples, scheduled periods were overlapped in such a way that individual working crews were engaged continuously without any inactive periods.

Total Project Time Breakdown

A breakdown of total time for the project — from start to finish — is illustrated in Fig. 1. This chart shows work periods covered in preparing process information memos, writing process and mechanical design specifications, drafting, procurement, and construction. Note in the figure variations in apparently similar projects — caused by differing complexity, labor conditions, etc.

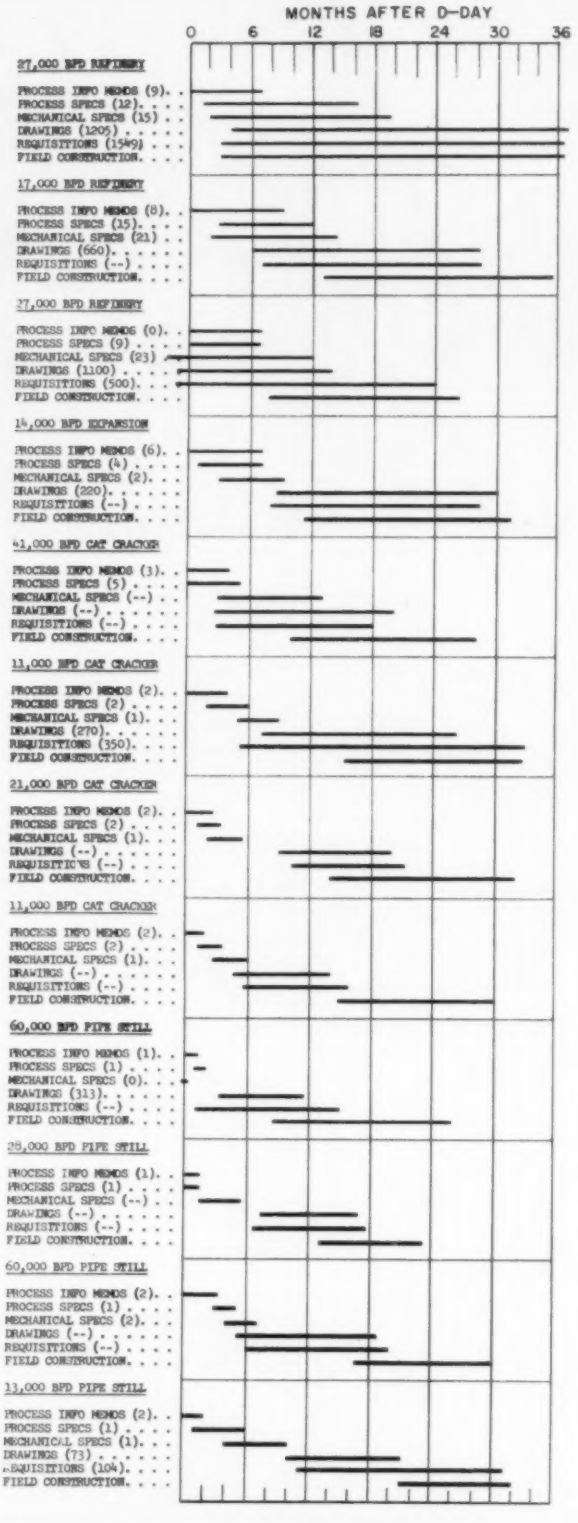
Normal overlapping of work by various departments is shown in this total time breakdown chart, which covers three complete refinery projects, three cat crackers and three pipe still jobs. In only four of these projects was actual field construction begun less than 12 months after project was authorized.

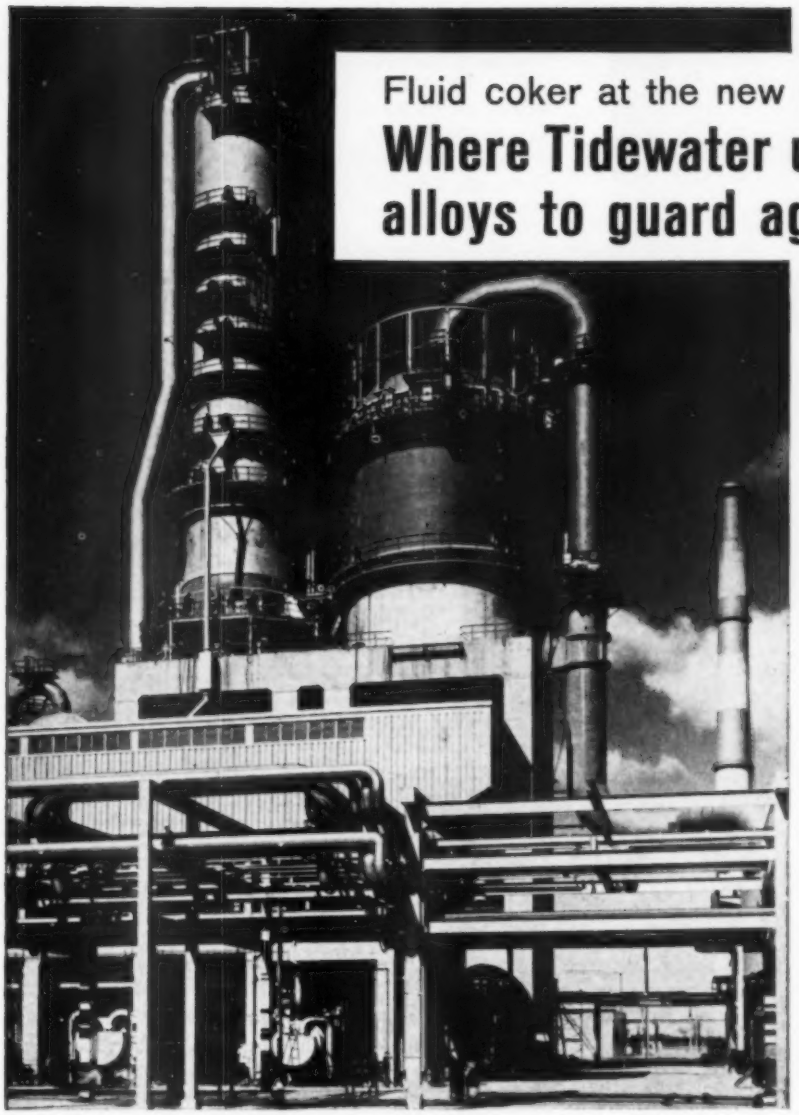
Some of the process work is often done during the discussion period preceding authorization, as was the case in the third item shown in Fig. 1.

Hours of engineering work after D-day—day when order is given to build the refinery—can be split among the various engineering groups in a fairly predictable way. For a large job — based on total engineering time — process engineering uses 12 percent of the time, mechanical engineering 8 percent, drafting 55 percent, procurement engineering 20 percent, and preliminary process information memos, estimating and scheduling 5 percent. This does not include services of a staff engineer for coordination, nor an operator for starting up.

Total engineering time for a standard-type crude pipe still would be about 20,000 hours; for a delayed coker of less standard design, 40,000 hours; a cat cracker of new design,

FIG. 1. Typical Engineering and Construction Times.





Fluid coker at the new Delaware Refinery...

Where Tidewater uses high nickel alloys to guard against corrosion

Here's the fluid coker at the Tidewater Oil Company's new Delaware Refinery, which boasts the world's largest initial capacity.

Like other units in this refinery, the fluid coker reflects latest practice in economical corrosion protection. To provide this protection, Tidewater engineers took full advantage of the properties of high nickel alloys. You'll find the details in the table below.

Throughout this ultra-modern refinery, high nickel alloys such as Monel* and Inconel* combat corrosion by mineral acids and other troublesome corrosives.

For more information, or for help with a corrosion engineering problem of your own, write Inco's Development and Research Division.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall St. New York 5, N. Y.

INCO TRADE MARK

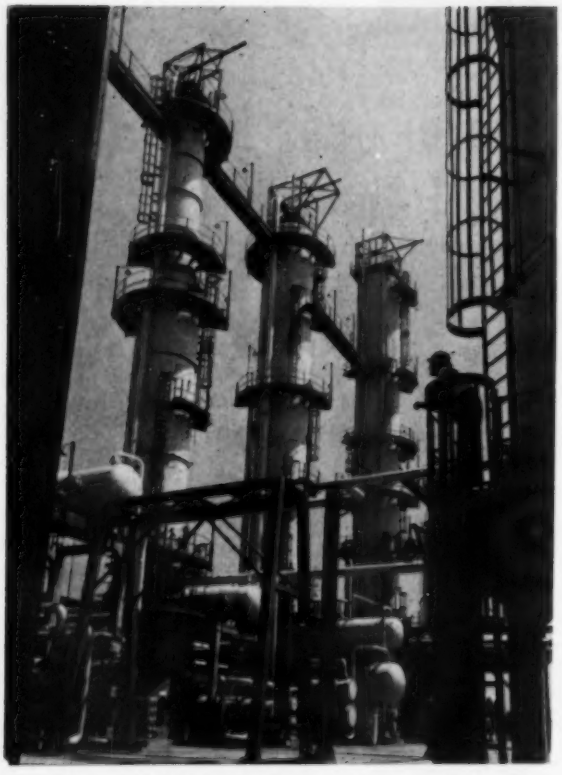
Schedule of Use of Monel nickel-copper alloy to combat corrosion by aqueous H_2S and HCl in fluid coker at the new Tidewater Refinery**

	EQUIPMENT	LOCATION	MATERIAL
Columns:	Fractionator	Top head	Monel-clad steel
		Shell, tray #17 to top	Monel-clad steel
		Trays #17, 18, 19	Monel alloy
Vessels:	Fractionator-accumulator	Nozzles	Monel alloy
	First commingler drum	"	" "
	Second commingler drum	"	" "
	Stabilizer accumulator	"	" "
	Blowdown quench drum	"	Monel alloy
	Main water seal vessel	"	" "
	Bypass water seal vessel	"	" "
Pumps:	Foul water pump	Casing, impeller	Monel alloy
Piping:	Foul water line, accumulator to stripper		Monel alloy

*Registered trademark **Where temperatures go above 500°-550°F, nickel-containing type 316 stainless and stainless-clad steel are also extensively used in this unit.

INCO NICKEL ALLOYS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Gulf Oil's new Catalytic reforming unit at its Port Arthur, Texas refinery. Installation will convert 26,000 bbl a day of low octane gas to high octane motor fuel

80,000 hours; a simple topping refinery, 100,000 hours, and a complete fuels refinery, 200,000 hours.

Hours for all this engineering work are spread over a long period. For example, the work of 6 to 15 men of the drafting group would be about 10,000 to 20,000 hours for a crude pipe still or a cat cracker, but would extend over a period of about 12 months because of waiting for manufacturers' drawings and for details from process and mechanical design divisions.

For one refinery construction job the procurement division was active for two years. Peak load for procurement took 18 men and lasted for three months. Most of the equipment was ordered four months after receiving process design specifications, but the work of reviewing manufacturers' drawings, writing supplementary specifications and assisting the purchasing department in final purchases continued until the refinery went onstream.

TABLE 1. Field Construction Patterns.

Activity	—Months of Active Construction Work— Catalytic Cracker	LPG Plant
Demolition and piling	4	1
Foundations	5	5
Furnace	4	3
Structural steel	8	4
Vessels	7	2
Pumps and drivers	5	2
Exchangers	2	1
Blowers	1	3
Piping	13	12
Electrical	13	10
Instruments	8	5
Compressor building	2	2
Control house	4	3
Insulation and paint	4	4

What the Engineering Department Does

In the larger organizations process engineers write basic process design memoranda and complete process specification for use by the other three groups — mechanical, drafting and procurement.

Process specifications give details on sizes of all towers, drums and vessels; type, size and tube distribution for furnaces as well as tube size, total heat transfer surface and duty; sizes, duties and special qualifications for pumps, compressors, heat exchangers and instruments.

Also included in process specifications are the interior design of the towers and vessels with some detail indicated for arrangement of piping. This specification alone — for a complete crude pipe still — uses about 1000 hours of work.

Mechanical engineers can start immediately after D-day to design offsite facilities, sewers, shops, buildings, marine terminals, roads and facilities for steam, power, water, air, housing and transportation.

Preliminary drawings are made showing locations and elements of process units as well as offsite facilities. A complete 25,000 bbl per day refinery may call for about 17,000 hours of work in the mechanical design division.

Drafting and procurement can proceed on the basis of the work of the process and mechanical divisions.

Drafting for a cat cracker with reformer section, for example, was found to take 25,000 hours for a total of 265 drawings. Drafting of water supply, sewers, storage tanks, piling and grading for a new refinery took 56,000 hours for a total of 480 drawings. For a refinery boiler plant, 11,000 hours of drafting time were needed for 110 drawings, and for an Edeleanu plant, 20,000 hours for 216 drawings.

The procurement engineering division is smaller than the drafting division, but larger than either of the design divisions. Procurement engineers write the detailed requisitions for materials and equipment. They also review manufacturers' quotations and drawings, and write supplementary specifications for equipment specified by other engineering groups.

Procurement engineering work on a particular 25,000 bbl per day complete refinery called for 55,000 hours.

The Project Schedulers' Job

Project schedulers must foresee probable bottlenecks which could delay completion of the refinery project. They then schedule engineering work so that maximum effort can be applied on any limiting items that may arise at an early moment.

For example, in scheduling a large, complicated reactor, schedulers must assume a long time in shop fabrication. Some preliminary drafting and procurement work will be scheduled for this item as soon as the first process specification work is completed.

Schedulers must see that preliminary blanket orders for standard pipe sizes and standard structural shapes are made and sent out early in the project.

Conferences with the field construction superintendent help schedulers prepare a realistic field schedule. This makes it possible to set the time schedule according to available manpower, and distribute work so that urgent items get priority treatment.

An experienced scheduler realizes that construction work will drag if an obvious lull exists between phases of the job. The working forces will be tempted to stretch the work in hand to fill the empty period on the schedule, giving the result of excessive manhours on the project.

Next Month, *The Refinery Construction Manual's* fifth chapter will discuss "Process Engineering and Design."

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Let Scovill Technical Service . . . most experienced in the field . . . help you establish the best heat exchanger tube specifications for equally trouble-free service in your own heat transfer equipment.

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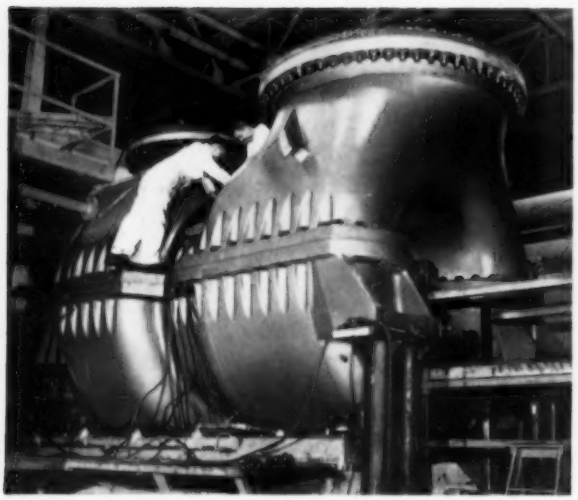
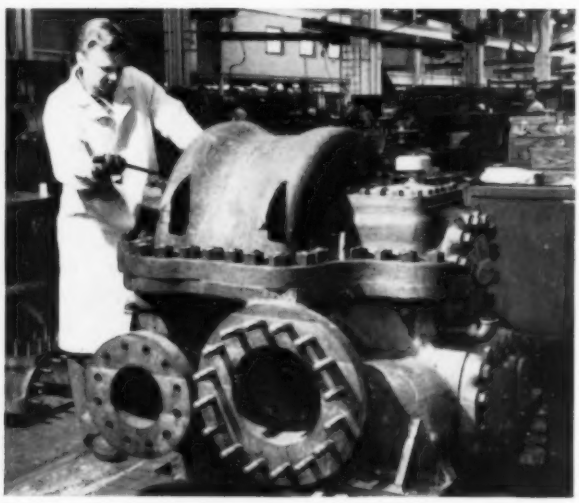
Which is the best way to compress gas?

That depends. The compressor that's right for small volume flow isn't right for large volume flow—and vice versa. With the widest selection of compressors in the field, Carrier has the right unit for your process. Equally important, with greater experience handling more different gases in its compressors than any other manufacturer, Carrier offers application skill unmatched in the industry. Shown below are a Carrier Centrifugal Compressor for small volume flow and an Axial Flow Compressor for large volume flow. For complete information about them, call your nearest Carrier office.
Or write Carrier Corporation, Syracuse, New York.

Carrier





For large volume flow beginning at 75,000 cfm, Carrier Axial Flow Compressors are the answer. This unit, rated at 276,000 cfm, was made for use in a butadiene plant in the southwest. Carrier Axial Flow Compressors offer distinct advantages for large volume flow. Their high efficiency effects a significant reduction in operating costs. And their dependability is proved—the hundreds now in use have given reliable service for a total of over 60 million operating hours. Frame sizes are rated up to 600,000 cfm when operating on air.

For small volume flow starting at 1000 cfm, Carrier Centrifugal Compressors are the answer. This unit, the smallest in the Carrier centrifugal line, is installed in a refinery in Texas. Carrier has manufactured compressors that withstand pressures up to 2400 pounds, are driven with drivers of over 10,000 hp and attain extremely low temperatures. Their ability to run 24 hours a day, 7 days a week, year in and year out, is a matter of record, demonstrated in chemical, petrochemical and refinery processes in plants throughout the world.

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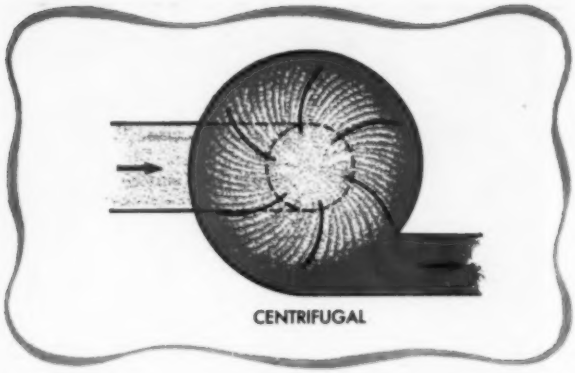
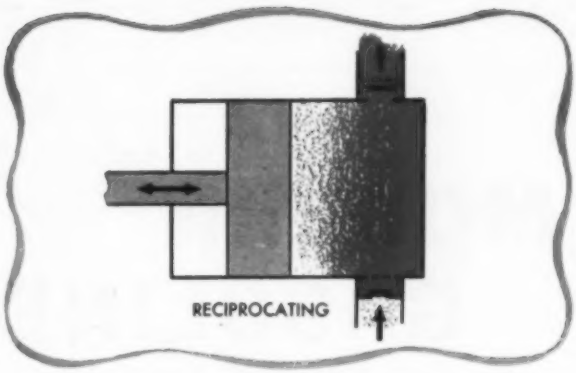
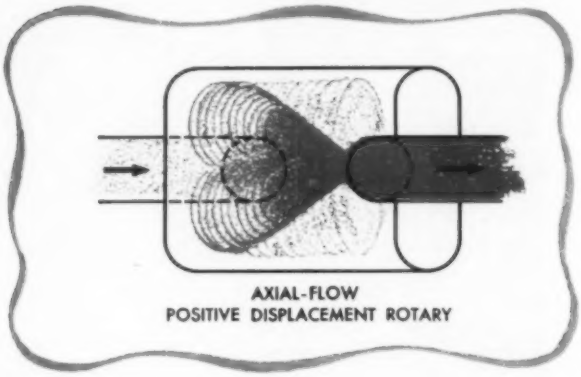
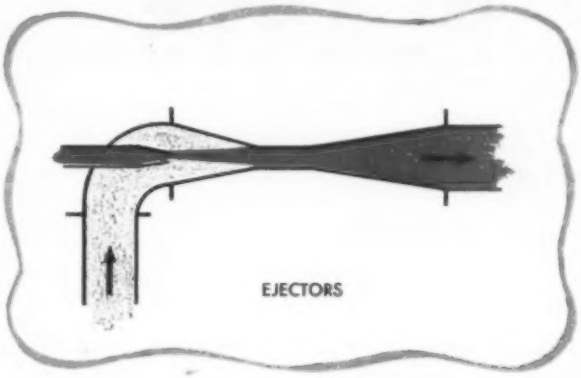




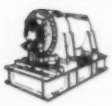




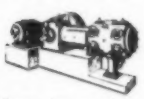
Which method is best for your PRESSURE or VACUUM requirements?

AIR or any other gas behaves differently under each of these methods of compression or evacuation. But for any set of operating conditions, *one method* will have advantages that make it the most practical and economical solution to the problem.

Ingersoll-Rand, the only manufacturer of *all four types* of compressors, is in a unique position to help you select the most efficient unit for any job. Here are a few general comments on each type.

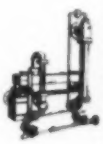


Centrifugal Compressors. Ingersoll-Rand centrifugal blowers and compressors are available in single- and multi-stage units, for handling large volumes of air and all other gases at vacuum and for pressures up to 2500 psi and higher. Sizes range up to 20,000 hp and capacities to 300,000 cfm. They can be driven by steam turbine, electric motor, combustion-gas turbine and hot-gas expander turbine.



Reciprocating Compressors. I-R reciprocating compressors are available in single- and multi-cylinder designs to meet a wide range of high-pressure, low-volume requirements. They have been furnished in sizes from ½ to 7,500 hp, for pressures to 35,000 psi and vacuums. Driver types may be electric, steam, oil or gas, and oil-free air can be provided by means of Type NL non-lubricated cylinders and valves.

Axi-Compressors. The Ingersoll-Rand Axi-Compressor is a compact, space-saving axial-flow positive displacement rotary compressor that offers unique advantages within its operating range. It delivers a steady flow of clean, oil-free air or gas and can be direct driven by electric motors or gasoline engines. Available in capacities from 100 to 12,000 cfm for pressures to 15 psi and vacuums to 15" hg. Higher vacuums can be produced with water injection or with two stage units.



Ejectors. For many applications, I-R ejectors offer maximum simplicity and economy, as they have no moving parts and require practically no attention or maintenance. They can be supplied for vacuums to 5 microns (0.000197" hg abs), as well as for pressures to 150 psig.

• • •

Your Ingersoll-Rand representative will be glad to give you complete information on any of these compressor or vacuum units — and help you select the one that's best suited to your particular requirements.

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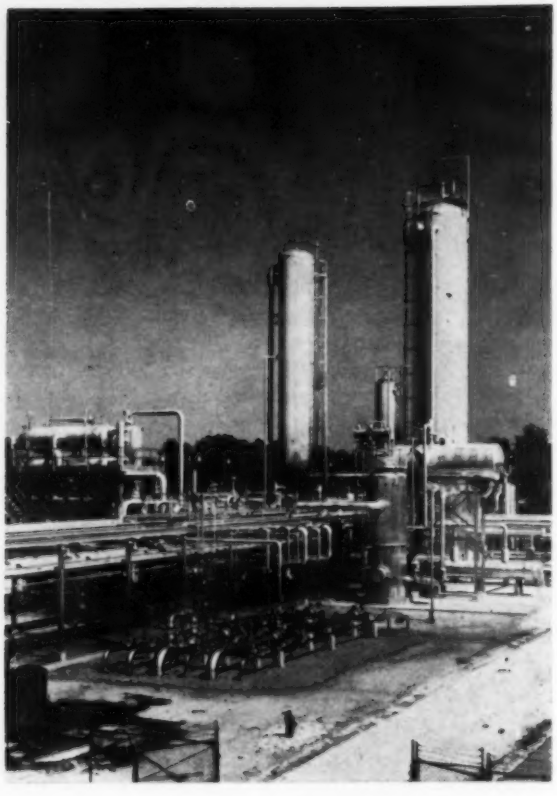


Dave Vondy
Constructive Engineering Company, New Orleans, Louisiana

Part 5: Refrigeration — Vapor Compression and Ammonia Absorption

LOW TEMPERATURE OPERATION is frequently advantageous in several process operations in gas processing and liquids recovery plants. Applications range from condensing tower overhead for high propane or ethane recovery to paraffin removal. Refrigeration is frequently used to improve absorber operation and to improve fractionation efficiency, is often used to simultaneously condense hydrocarbon liquids and water from a moderately rich gas.*

Refrigeration Fundamentals

Refrigeration effect is obtained by reducing pressure on liquid refrigerant so that it boils at sufficiently low temperature to remove heat . . . as heat of vaporization for the refrigerant . . . from the process stream. Best refrigerants are liquids with a high heat of vaporization and also having a low vapor compression load. Most common for industrial purposes are ammonia and propane at usual temperatures . . . say −10 up to 40 F . . . water for higher temperatures, and high vapor pressure liquids such as ethylene for deep refrigeration.

Conventional rating method for refrigeration equipment is a carry-over from the ice-making industry, where one ton of refrigeration is equivalent to 12,000 Btu per hr. Actually, rated capacity is determined at a given set of operating conditions. Operating capacity will vary according to temperature level of the refrigeration, temperature of the refrigeration system's condenser, and several other variables. Thus, the conventional ton of refrigeration rating system often causes some problems, due to misinterpretation.

Application of refrigeration. Process streams are usually cooled by passing them through a tube bundle immersed in boiling refrigerant. In some instances, though, a separate flash tank is used for vapor separation while refrigerant flows through a heat exchanger to chill the process stream. This scheme can be used to advantage when refrigerant film heat transfer coefficient is significant in overall transfer rate and can be increased by positive refrigerant flow at the transfer surface.

To avoid elaborate control systems when there are several loads, it is common practice to arrange two or more loads in series and to pass all the refrigerant through each exchanger. When a secondary load is located remotely, a liquid supply at condenser pressure can be piped to this remote location and the vapors returned to the vessel used for the primary load.

Design for atmospheric temperature. All vessels in a refrigeration system must be designed to withstand vapor pressure of the refrigerant at atmospheric temperature. Otherwise, the closed-system design would result in loss of refrigerant through relief valves if and when the system were shut down.

Vapor Compression Systems

In a vapor compression system, a compressor is used to boost refrigerant vapor from the required low pressure to an elevated pressure at which it can be condensed, normally with cooling water.

Fig. 33 illustrates a typical flow scheme. Vapor from the compressor is condensed and expanded into the chiller, and low-pressure vapor from the chiller is returned to the compressor. No process pumps are used but the cooling water would usually be pumped. The compressor is protected

*See Modern Gasoline Plants, Part 2, "*Cold Absorption Plants for Liquid Recovery*," The Refining Engineer,* June 1958, page C-16.

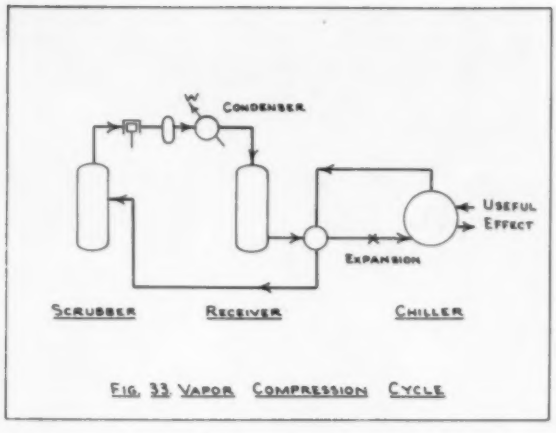


FIG. 33 VAPOR COMPRESSION CYCLE

from damage by liquids by a scrubber and further by a liquid subcooler, vapor superheater which will cause carry-over liquid particles to be evaporated.

Superheating is particularly important when a refrigerant (such as butane) is used which can condense upon compression without cooling, and also during cold weather to avoid liquid carry-over to the compressor, which would cause valve trouble.

A trap is provided in the compressor discharge line to remove lubricating oil. If this foreign oil is not removed, it will cause trouble by reducing the heat transfer in exchangers and by collecting in low points in the system. Lack of attention to this problem is often a cause of trouble with a facility.

Any foreign vapor will collect in the condenser and cause excessive condensing pressure increasing compression load. Air and other gas such as ethane should be thoroughly purged from the system and avoided in refrigerant to be added to the system. The refrigerant should also be free of material having a lower vapor pressure (higher boiling point) since such material will collect in the chiller and require a lower pressure for a given refrigeration temperature increasing compressor load. Such increases in compression load caused by foreign material are significant — they may well reduce the refrigeration capacity by more than 20 percent.

When possible a refrigeration cycle is usually selected which will allow operation above atmospheric pressure to avoid air entrance into the system.

Propane Often Most Economical System

Propane is generally the most economical refrigerant for process use when available relatively pure. For this reason care should be taken when charging a system with a plant product to insure that as pure propane as possible is used. Quite often a cylinder for compressing propane can be added to a compressor required for other use, and the engine size increased to handle both loads. When several process gas compressors are used, as to compress inlet rich gas to a plant, it is often practical to distribute the refrigeration load between two or more compressors to prevent complete loss of refrigeration in event of breakdown and during overhaul. When a refrigeration cylinder is added to a process compressor, provision is usually made to unload this cylinder quickly as with an automatic valve lifter or by-pass in event of trouble with the refrigeration cycle such as loss of cooling water.

When special compressors are used, it may be practical except in very small sizes to use two compressors to provide maintenance flexibility. Also in small plants it is often practical to drive a generator with the compressor engine to provide power to operate process pumps or to supply power for some other use as to provide lighting in plants remotely located.

The typical propane cycle of Fig. 34 is for a chiller temperature of 5 F and a condensing temperature of 83 F. Subcooling of the condensed liquid and superheating of the low-pressure vapors are shown. It can be noted that the compression load increases with increase in condensing temperature (increased pressure) and with decrease in chiller temperature (decreased pressure).

Ammonia Systems Popular for Small Plants

Because it is an excellent refrigerant readily available in small containers in the pure anhydrous state, ammonia has found wide use in small plants. Special compressors are used, incorporating protection against liquid load damage and design for high compression ratio with such features as cylinder cooling and special loading valves. All-steel equipment and accessories must be used since ammonia attacks copper and its alloys. Nominal care in handling to avoid excessive exposure is adequate to prevent injury when operators recognize the hazard.

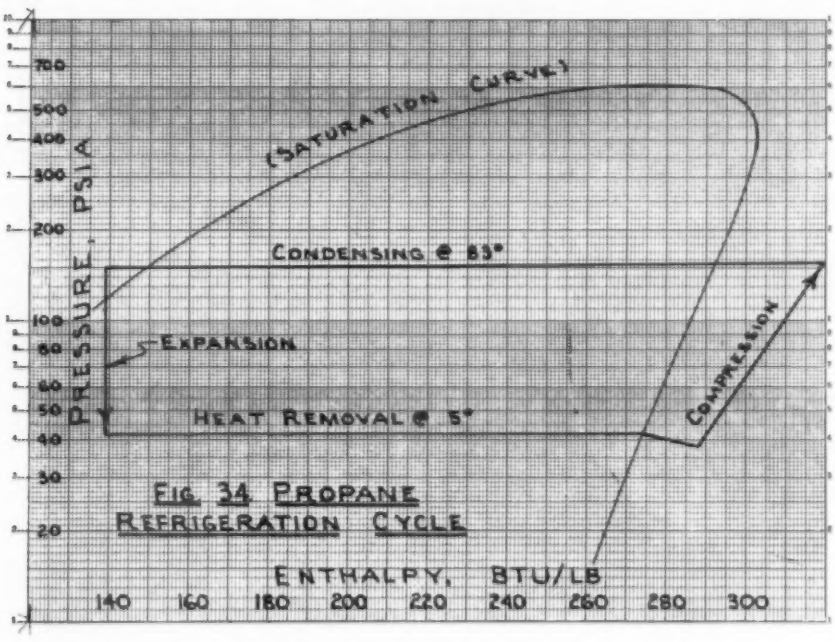
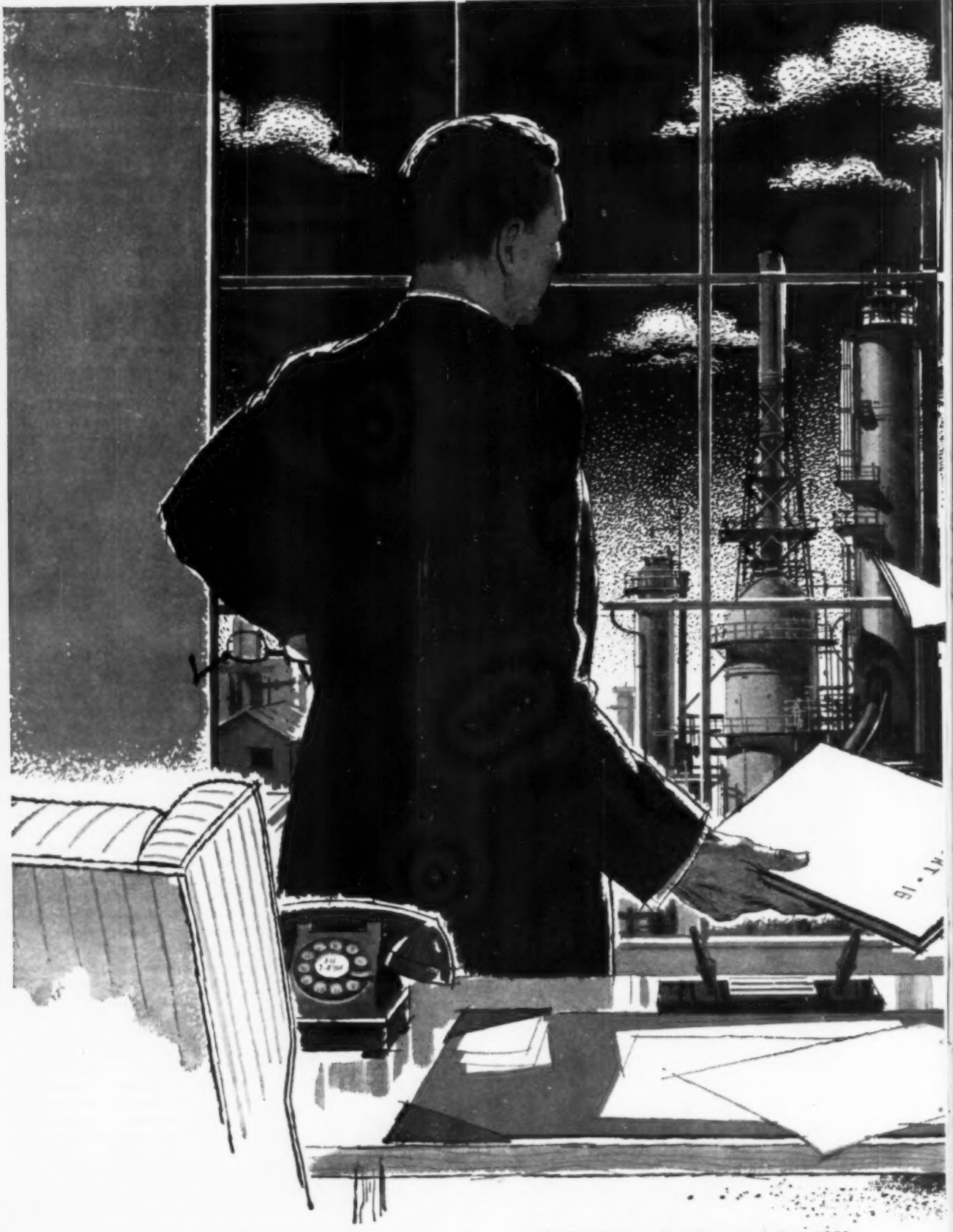


FIG. 34 PROPANE REFRIGERATION CYCLE

Fig. 35 is a plot of ammonia compressor shaft horsepower as a function of chiller and condensing conditions. As indicated before, compression load is increased by reduced chiller temperature and by higher cooling water temperature. Highest compression load occurs during summer months when high atmospheric temperature causes highest process cooling load and highest cooling water temperatures.

A system designed for maximum load will not be used to full advantage in the winter time if a constant temperature is maintained on a load varying



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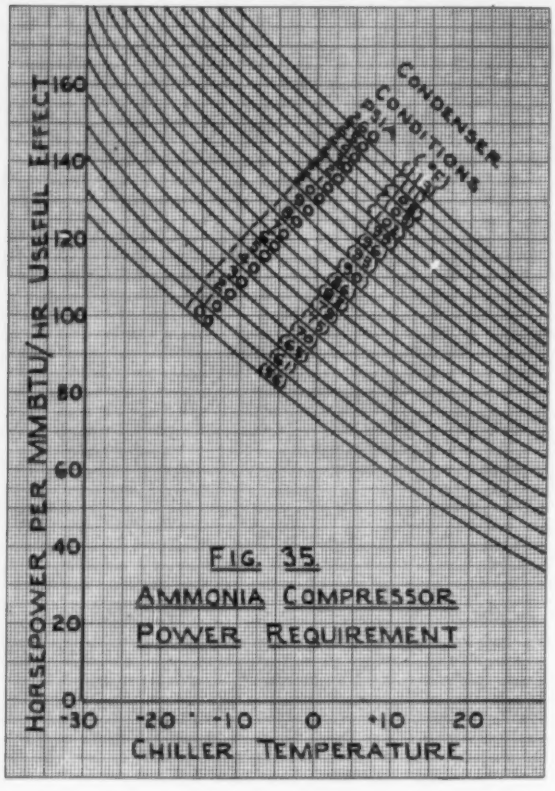


FIG. 35
AMMONIA COMPRESSOR
POWER REQUIREMENT

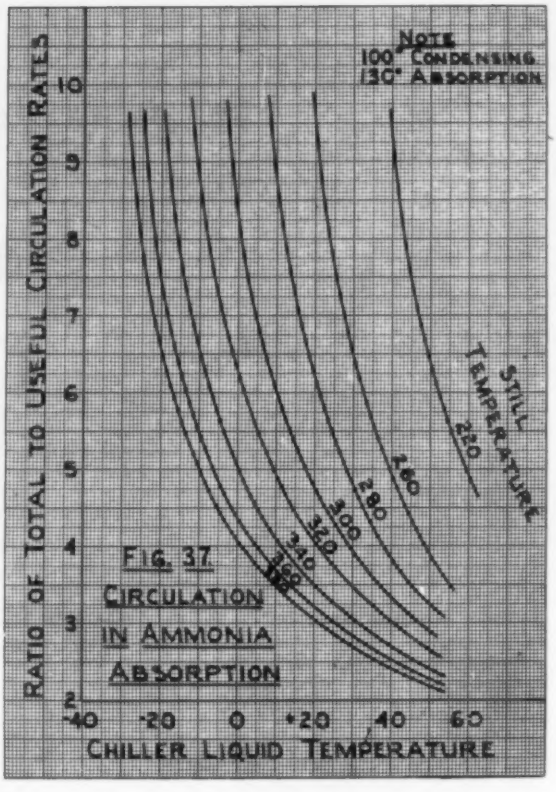


FIG. 37
CIRCULATION
IN AMMONIA
ABSORPTION

with atmospheric temperature. It is frequently practical to design for higher refrigeration temperatures in the summer (lower in the winter), and likewise from day to night, to realize maximum utility from the equipment throughout the year.

Close temperature approach in the condenser and the chiller, usually less than 10 F is justified to reduce compression load, but due to limited choice of compressors for a particular situation, a compressor must be selected to satisfy requirements under approximate conditions and exchanger conditions set accordingly.

Ammonia Absorption Refrigeration

Ammonia can be absorbed in water at the low chiller pressure and the solution pumped to a still for removal of the ammonia at adequate pressure to enable condensation with cooling water. This scheme has high heat, cooling and pump loads compared to a compression cycle, but avoids use of a gas compressor which may require considerable maintenance. Absorption refrigeration shows advantage when the load is high and utilities are cheap.

Design of an ammonia absorption facility is complicated by nonideal liquid mixtures of water and ammonia, and special attention must be given to heats of solution. Ade-

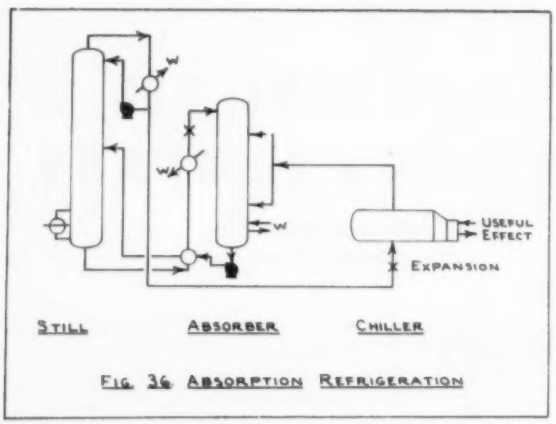


FIG. 36 ABSORPTION REFRIGERATION

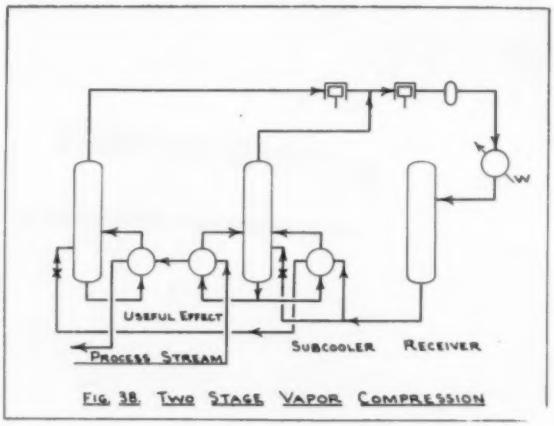


FIG. 38 TWO STAGE VAPOR COMPRESSION

quate engineering data is, however, readily available in the literature. A Ponchon-Savarit diagram (enthalpy vs composition) is useful in design calculations.

A typical absorption cycle is shown in Fig. 36. Ammonia is absorbed in water in an absorber vessel which is cooled with water to remove the high heat of absorption. Rich solution from the absorber is pumped through an exchanger to recover heat from the bottoms leaving the still, and then to the still; bottoms from the still are flowed to the absorber after cooling. Overhead product from the still, which is essentially pure ammonia, is condensed and expanded into the chiller. Several horizontal vessels are often used for absorption instead of one, usually with gravity flow of solution from one to another.

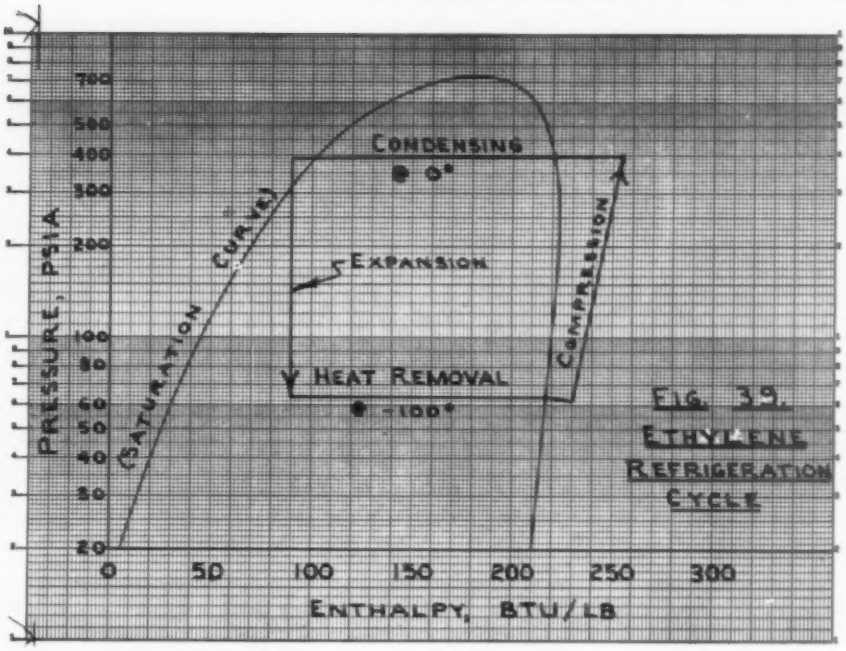


Fig. 39. Ethylene refrigeration cycle.

At very low temperatures, water tends to accumulate in the chiller and it may be necessary to recycle a small stream of liquid from the chiller because chiller temperature increases at a given pressure with increase in water content.

Total circulation rate is a function of the chiller temperature and the still bottom temperature, as shown by Fig. 37. The higher the still bottom temperature, the less ammonia left in the water and therefore the greater capacity the water has to absorb ammonia. A still temperature above 320 F is generally necessary for economical operation but special situations where heat can be supplied at a lower energy level from a cheap source require special consideration. The lower the chiller temperature the more important that the still bottom be at a high temperature.

Comparison of Absorption and Compression Methods

High cooling water requirement for an absorption system is often an economical disadvantage which should not be overlooked in application. Relatively little operating trouble and low maintenance cost (since basic equipment is more apt to be familiar to operators) may have considerable value particularly in small remote plants.

Comparison of relative operating ease between absorption and vapor compression systems with ammonia refrigerant can be illustrated by the result of loss of cooling water flow in each. In absorption, loss of cooling water causes loss in refrigeration effect but all equipment stays in operation when an adequate control system is used, and the system lines itself out once cooling is re-established. In a compression system the compressor(s) must shut down automatically or refrigerant will be lost due to excessive condenser pressure. When the cooling water loss is corrected, the compressor(s) must be started and loaded in a special manner manually, unless costly sequential starting equipment is installed.

Deep Refrigeration

To obtain very low temperatures, various cycles and combinations are used since a simple cycle will not meet the requirement.

Two stage refrigeration. All vapor is compressed to pressure adequate to enable condensing with cooling water. Part of the liquid is expanded into a chiller which is used to subcool the remaining liquid which is in turn expanded to a lower pressure chiller for useful effect. The vapors are compressed by a two stage compressor with the vapor from the liquid subcooler introduced between stages.

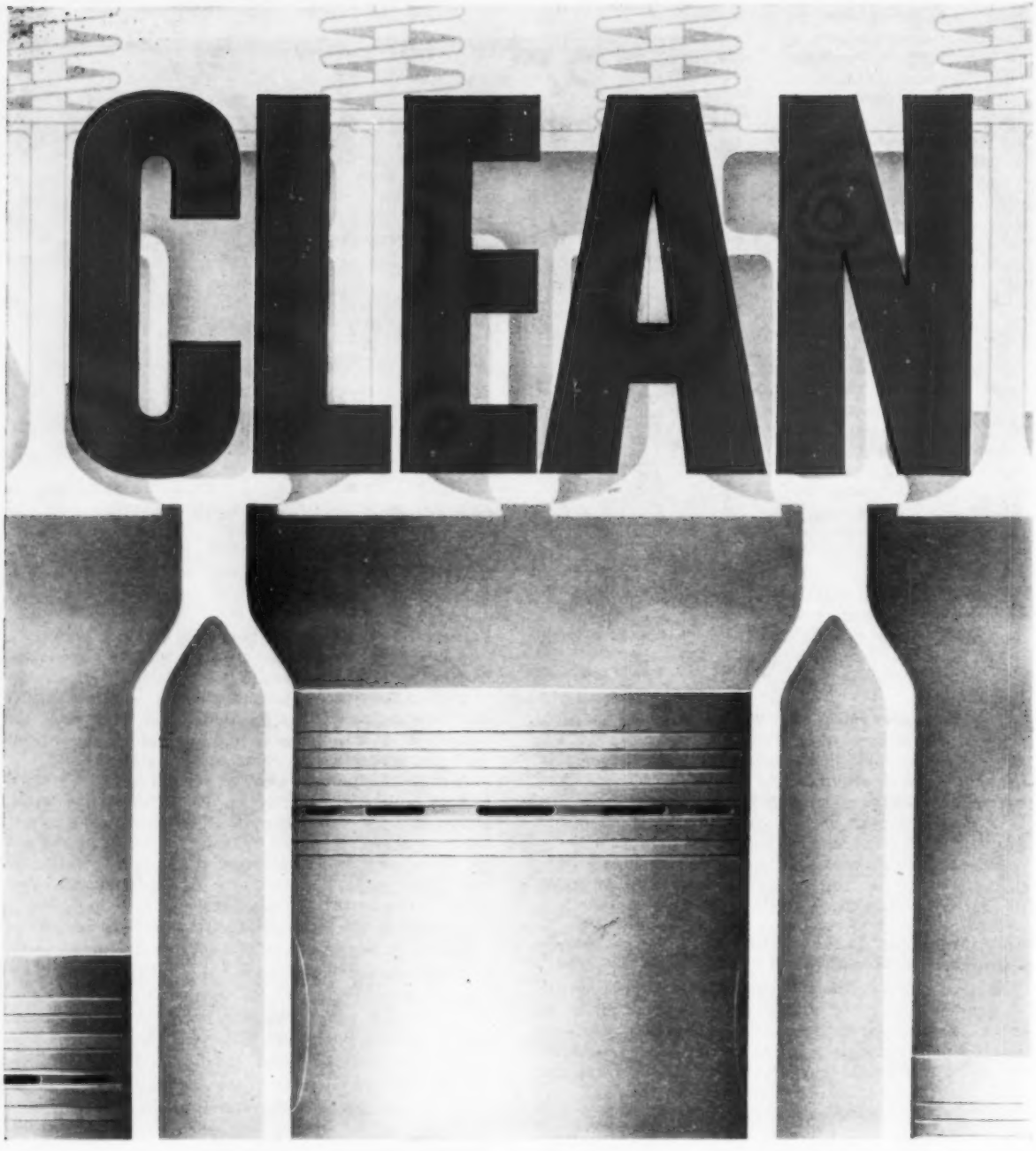
A cycle of this type may be used to advantage when process cooling is to be carried out at two energy levels, one appreciably higher than the other, or when a considerable temperature reduction by refrigeration is required and the two stage cycle enables more economical operation by transferring part of the heat at a higher energy level. The latter application is shown in Fig. 38.

Cascade system. Refrigeration is developed at two or more energy levels and the useful effect of a higher temperature cycle used to condense the vapors of the next lower energy cycle. Thus, propane can be used to condense ethylene vapors and a temperature below −100 deg obtained. Fig. 39 shows a typical ethylene cycle. Ethylene cannot be condensed with cooling water, and the useful effect decreases significantly with increase in the condensing temperature.

For lowest process temperatures, as required in natural gas liquefication, advantage is usually taken of the temperature drop which accompanies reduction in pressure. Thus, by cooling to some low temperature, natural gas at an elevated pressure can be expanded to a low pressure and partially liquefied. The cold uncondensed vapors are then recirculated with refrigeration recovered by regenerative heat exchange to obtain further condensation. Removal of additional energy increases condensation, so work is usually done in the expansion step. Flowing the gas through an expansion-type turbine is an example of this.

Next Month in Modern Gasoline Plants:

"Dehydration and Hydrate Inhibiting" will discuss methods used for water content reduction, from the standpoints of both dewpoint control and eliminating potential operating problems. ★ ★ ★



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THERE'S GOOD NEWS TODAY...

at PROCON

Philadelphia, Pennsylvania—Work was recently completed on two 26,000 B/SD Platforming® units at Gulf Oil Corporation's Philadelphia refinery by Procon Incorporated. Two 26,000 B/SD Hydrobon® units used with the Platformers were also built by Procon. The Platformer heaters were the largest ever built. Procon engineers recommended single heaters for each Platforming unit instead of two smaller heaters for best use of available space and maximum construction economy.

London, Ontario, Canada—Procon (Canada) Limited recently completed the installation of flaking mills, ovens, conveyors, dust collection systems and related equipment as part of a plant modernization program for Kellogg Company of Canada, Ltd. This construction covered improvements to Kellogg's cereal processing plant at London, Ontario.

Al Kuwait, Kuwait—Work is proceeding on 4,000 B/SD Platforming-Unifining* units and a 7,200 B/SD prefractionator being built by Procon (Great Britain) Limited for Kuwait Oil Company at Kuwait on the Persian Gulf. Work covers mechanical and structural design, engineering, procurement, inspection and supervisory services for Kuwait.

Heide, Germany—Construction was recently completed on a 4,000 B/SD Platforming unit under the supervision of Procon (Great Britain) Limited for Deutsche Erdol-Aktiengesellschaft (DEA). This is part of an extensive reconstruction program, and will supply premium gasoline to Northern Germany and Denmark.

Bakersfield, California—The construction of Mohawk Petroleum Corporation's 925 B/SD Unifining unit was recently completed by Procon Incorporated. This unit processes thermally cracked naphtha derived from California crude. The Unifining unit was built at Mohawk's Bakersfield, California, refinery.

Procon service is available to the oil refining, petrochemical and chemical industries, anywhere in the world. New plant construction, expansion or modernization, whatever the requirement, Procon will do it right, and on time.

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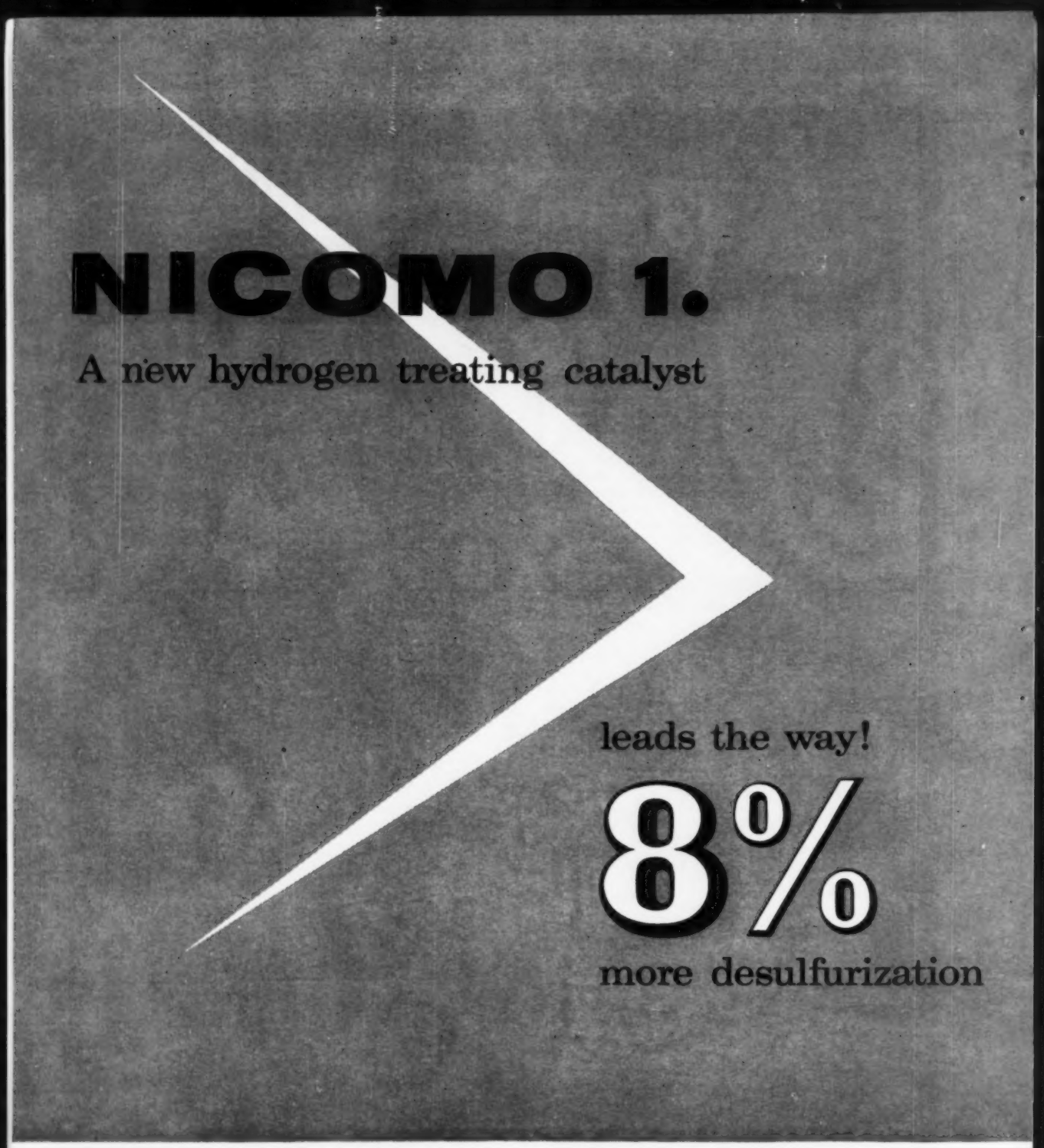

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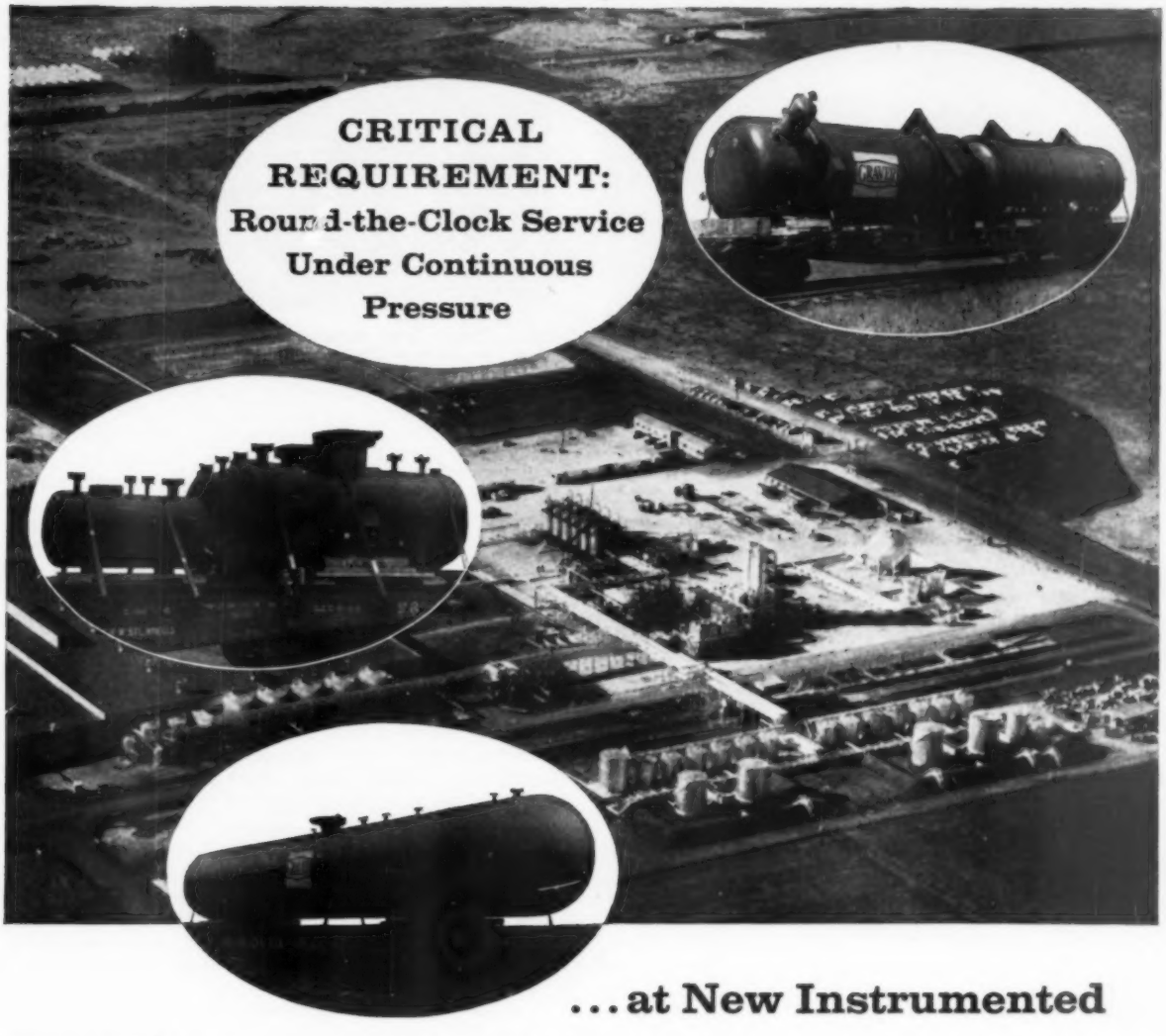

...at New Instrumented GENERAL TIRE Synthetic Rubber Plant at Odessa

The nation's first privately financed and first completely integrated synthetic rubber operation owned jointly by The General Tire & Rubber Company and The El Paso Natural Gas Company at Odessa, Texas utilizes 880 instruments for absolute and continuous control by a single operator.

Just 22 months after the agreement was signed between The General Tire & Rubber Company and The El Paso Natural Gas Company, two new plants costing $32,000,000 went on stream at Odessa, Texas to manufacture GR-S synthetic rubber. Now in full production day and night, a continuous stream of raw materials enters the General Tire plant at one end, leaving the other end as bales of synthetic rubber. The entire manufacturing process demands the utmost care in the control of timing, temperatures, pressures and the proportionate quantities of the various ingredients.

Eighteen pressure vessels fabricated by Graver of ASTM A-285 Grade C flange quality steel are important links in the modern automation chain at the General Tire plant. Built to be in operation around-the-clock under continuous pressure, the 18 pressure vessels are symbolic of the meticulous fabricating craftsmanship Graver applies to processing equipment for the petrochemical, chemical and petroleum industries. Over a century of experience qualifies Graver to tackle the most exacting specifications.

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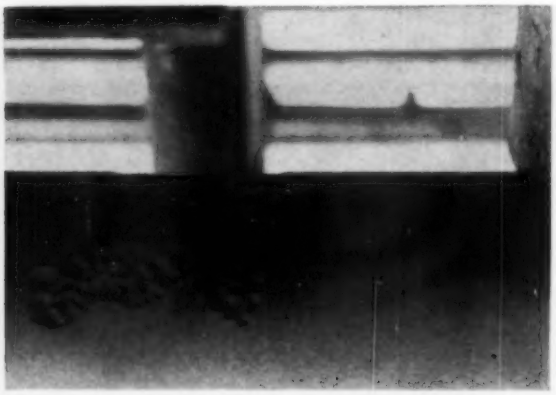

FIG. 1. **An ethyl alcohol line at Shell Chemical** Corporation's Houston plant became corroded where the line rested on metal supports. This view shows the pitted area after sandblasting.

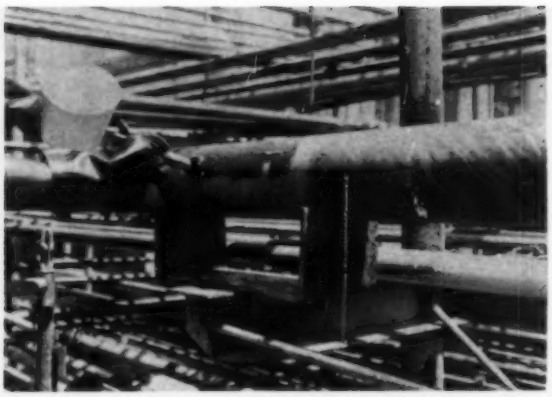

FIG. 2. **Second step in repairing the line** was the painting of a liquid formulation of EPON adhesive around the sanded areas. Pipe is resting on a temporary support.

Epoxy resin and glass cloth combine to make . . .

Quick, Dependable Pipe Patches

J. D. Wyant, *Shell Chemical Corporation, Houston, Texas*

PATCHES MADE OF PLASTIC ADHESIVE and glass cloth have provided a durable, fast and inexpensive method of repairing corroded pressure vessels and piping at Shell Chemical Corporation's Houston plant.

In the new method, a liquid formulation of EPON® adhesive — manufactured by Shell Chemical Corporation — is combined with layers of glass cloth to make plastic patches. These patches have proved resistant to most of the solvents and corrosives used at Shell's Houston plant. In addition, they will stand continuous exposure to temperatures ranging up to 250 F and pressures up to several hundred pounds per square inch, depending on the size of the repair and the form of the patch.

The plastic patches can be applied without curtailing operating schedules except to depressure the equipment for the time required for application and cure. They can be used in the presence of flammable vapors and have proved successful where equipment size or wall thickness precludes the use of conventional clamps or bands.

The epoxy resin adhesive is easy to use. The resin is mixed with a curing agent and applied to the glass cloth. The resin sets up in from two to six hours.

Here are some of the maintenance problems the epoxy resin adhesive patches have solved at Houston:

One of the main process lines had been severely damaged by external corrosion at 45 different spots, but had not yet eaten through. Carrying ethyl alcohol, the all-welded 6-in. steel line is under the supervision of the Alcohol and Tobacco Division of the Internal Revenue Service which requires welded lines exclusively. To replace the corroded sections and reweld the line would have meant a shut-down of the ethyl alcohol unit, an expensive operation.

As an alternative, the maintenance department wrapped the corroded spots with plastic bandages. Use of these materials in temporary repair work had been under study for almost a year. Some of them — particularly those made with epoxy resin — showed that they could stand up against corrosive chemicals at medium heat and pressure over ex-

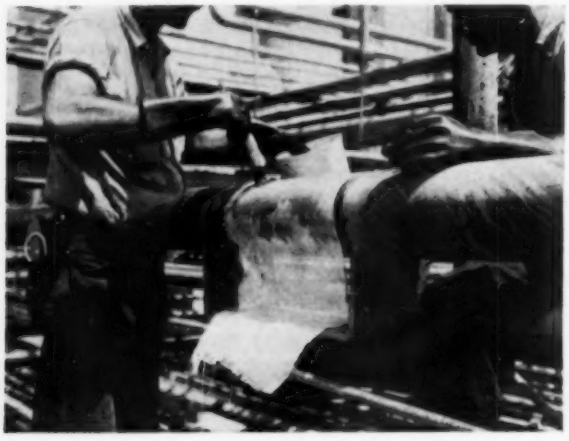

FIG. 3. **Next, a layer of glass cloth was wrapped** about the treated area. Adhesive and additional layers of glass cloth were added until the bandage was four plies thick.

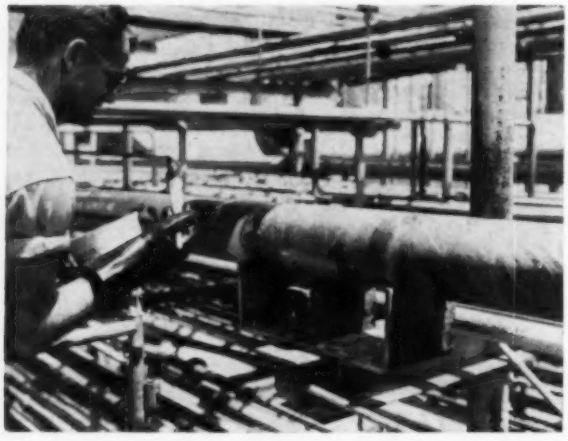

FIG. 4. **This shows the completed repair,** with the wear plate in position. The wedges and the temporary support were removed after the resin had cured. The line — damaged in 1956 — is in operation today, thanks to the EPON adhesive bandage.

tended periods.

The pipe had become corroded where it rested on its metal supports. It was raised and the rusted areas were sandblasted. A liquid formulation of epoxy adhesive was painted over the sanded areas, and a layer of glass cloth wrapped around it. Adhesive and additional layers of glass cloth were added until the bandage was four plies thick.

When the wrap was completed, a steel plate, which had been rolled to fit the contour of the pipe, was coated with resin and held against the pipe with wooden wedges until the adhesive had cured. The wear plate distributed the stress of the support on the pipe and absorbed the abrasive movement caused by thermal expansion. After the adhesive had cured (about six hours), the repaired area was repainted and the temporary supports removed.

The line is in operation today, and on the basis of findings on such plastic bandages, it is expected to remain so for many years.

Another case involved a leak in a 4-in. nozzle carrying the chemical feed into one of the columns in the allyl alcohol production chain. Because of the awkward location, the leak could not be stopped with gasket material or pipe clamps. Welding would have meant shutting down the column, venting the gas and removing the internal equipment and packing. The job would take 25 man-days.

Instead, the leak was bound with glass cloth and epoxy adhesive. The job took 10 hours, and the column was kept in operation until the next scheduled shutdown – one month later.

In several cases, epoxy-glass cloth patches have been used in direct contact with corrosive chemicals. One such application involved sulfuric acid fumes.

In this case, the rubber liner in an 18-in. steel duct carrying the fumes failed and the acid ate a hole roughly 5-by-8 in. through the duct wall. The break was wrapped with two layers of glass cloth saturated with adhesive. The patch stood up for six months, after which time the new duct was delivered and installed.

The adhesive and glass cloth necessary for emergency patching are now carried in warehouse stock at the Houston plant. To date, these materials have been used primarily for patching and repairs. In addition, the resin and glass cloth have been used to reinforce weak materials such as lead pipe. It is expected that new applications will be suggested by the success of these materials in the repair field, and that epoxy resin, reinforced with glass cloth, will be used increasingly as a construction and structural material. ★ ★ ★

OPERATING GUIDE COMPUTER GOES ONSTREAM . . .

This operating guide computer has been successfully placed into operation as a catalytic cracking unit at Esso Standard Oil Company's Baton Rouge, Louisiana, refinery.

New unit — first of its kind in the process industries in this country — was engineered and constructed by Leeds & Northrup Company. The system measures 160 process variables, of which 27 are computed operating guides such as catalyst circulation rate, carbon burning rate, material balance, etc.

In addition to computing operating guides, the equipment prints out off-normal conditions and furnishes on demand hourly and daily log sheet summaries of process operating data. The system incorporated a general purpose digital computer to make all the calculations necessary.

Esso spokesmen say the system will not only enable the operators to improve process performance, but will also be used to develop techniques for ultimately "closing the loop."

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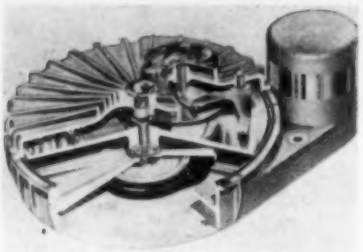
It's New Refining-Processing Equipment

New Computer Memory Unit



Memory unit shown here is a basic element in an advanced control computer system developed by Genesys Corporation. The dynamic memory processor is a hermetically sealed 8-in. disc with 2 recording modes. One mode uses fixed channels for the many variations of digital computation and control, the other a scanning head channel for data processing and correlative control. Hermetically sealed for use even in corrosive atmospheres, applications include fractionator control, optiminzation of cracking operations, etc. *Genesys Corporation.*

Circle number (41) on reply card.

Square-Root Integrator

New, compact square-root integrator is designed to provide a continuous means of automatically totaling flow. It can also be adapted to miniature strip chart flow recorders, forming an electro-mechanical integrator. Operating temperature range of the instument is —40 to +150 F. *Librascope, Inc.*

Circle number (42) on reply card.

New Insulation Material

An acid-resistant insulating and refractory material has been created which is 99 percent fused silica and can neither oxidize nor absorb moisture. It is said to be unaffected by all acids, with the exception of hydrofluoric and hot phosphoric. Insulating value of one inch of this material is equivalent to that of 18 in. of acid brick at an operating temperature of 250 F, according to the manufacturer. *Pittsburgh Corning Corporation.*

Circle number (43) on reply card.

Electronic pH Meter

New compact pH meter for fast continuous service over a wide range of field and laboratory applications is now available. Electronic unit measures 5½ by 6¼ by 2 in. and is said to be ideal for accurate determination of pH in raw, untreated, treated, potable, cooling and waste waters, boiler condensates and feed waters, and oilfield blends and brines. *Hagan Chemicals & Controls, Inc.*

Circle number (44) on reply card.

Condulets Detect Danger

New condulets provide at-a-glance indication of operating conditions. A high-speed flasher on the alarm light attracts operator's attention. An independent circuit can actuate a horn, siren, or bell, if an audible signal is also desired. They can be used to indicate normal and abnormal temperatures, pressures, liquid level, speed, load or any other conditions. *Crouse-Hinds Company.*

Circle number (45) on reply card.

Direct-Reading Viscometer

A convenient, simple, direct-reading viscometer has been develoned to measure the kinematic viscosity of liquid in a continuous flow process. Viscosity is read from a single manometric column without corrections or calculations. It works within an accuracy of 2 percent. *National Bureau of Standards.*

Circle number (46) on reply card.

Tank Level Detector-Controller

Major technological advances have resulted in lowering the cost of this instrument to make it competitive pricewise with conventional float-level controllers, according to the manufacturer. No part of it extends into the tank or vessel, and thus is completely free from fouling and readily accessible for maintenance. *Industrial Nucleonics Corporation.*

Circle number (47) on reply card.

Electronic Leak Detector

New instrument is a special type of mass spectrometer "focused" on helium. It locates and gives a precise indication of the size of leaks in pressure, vacuum and hermetically sealed equipment. An audible alarm allows the operator to locate leaks while concentrating on probing the suspected area. *Consolidated Electrodynamics Corporation.*

Circle number (48) on reply card.

Forged Steel Couplings

Availability of a newly-designed forged steel coupling, produced in sizes No. 5½ and No. 6, which are said to be both stronger and lighter than cast steel couplings used in most of the same applications, has been announced. The new forged steel couplings are being offered at a lower cost than cast steel. *Koppers Company, Inc.*

Circle number (49) on reply card.

Catalyst Support Material

A new grade of activated carbon for use as a catalyst support material has been developed. It is said to give better performance than previous grades in a wide variety of uses other than as a catalyst support. The new carbon is in form of 3/16-in. diam pellets for uniform impregnation and easy reactor charging. *National Carbon Company.*

Circle number (50) on reply card.

New Refining Literature

Storage Tank Catalog

New 36-page storage tank and plate fabrication catalog is now available. Fully illustrated catalog describes all types of storage systems, including floating tanks, underground storage tanks, water storage tanks and treatment vessels. Also included is information on available facilities for fabricating all types of steel, aluminum and alloy plate vessels and structures. *Hammond Iron Works.*

Circle number (51) on reply card.

Magnetic Flowmeter Specs

Obstructionless magnetic flowmeter utilizing the principle of electromagnetic induction to produce an a-c signal, which is directly proportional to flow rate, is fully described in new 4-page technical bulletin. *Fischer & Porter Company.*

Circle number (52) on reply card.

Steam Trap Manual

New 40-page engineering manual is designed to assist the engineering and maintenance profession in the sizing, specifying, selection and buying of steam traps and other fluid specialties. Piping details show correct methods of installing traps for a wide variety of applications. A dozen tables make it easy to select traps for various equipment sizes. *V. D. Anderson Company.*

Circle number (53) on reply card.

Catalytic Sweetening Process

A 4-page brochure explains new catalytic sweetening process. Literature also provides useful application information drawn from actual operational data. A comprehensive discussion of chemical requirements as well as treating costs is included. Flow diagrams and installation photos are provided. *Petreco Division-Petrolite Corporation.*

Circle number (54) on reply card.

CO Boilers Described

Boilers for burning CO gas are described in a 20-page catalog which explains design features that recover both chemical and sensible heat from waste gas. Cutaway views of construction features and tangential burners are included along with four pages of engineering data on waste fuel products. *Combustion Engineering, Inc.*

Circle number (55) on reply card.

Pump Nomograph Available

This nomograph enable engineers to calculate ideal capacities for the controlled volume pump and the chemical holding tank within a matter of seconds. All one needs to use the nomograph is the concentration of the chemical solution to be metered, the required chemical dosage and the flow rate of the process stream. *Milton Roy Company.*

Circle number (56) on reply card.

Corrosion Resistant Valves

Catalog describes new line of stock, wedge gate, check, throttle and digester cap valves. It tells how each unit has been designed for a specific service, to meet individual conditions of use. Each is built of a special alloy or plastic. *W. G. Rovang and Associates, Inc.*

Circle number (57) on reply card.

New Literature

Stainless Steel Booklet

A completely revised 40-page booklet on the use of stainless steel is now available. It includes special sections on the process, plastics and petrochemical industries. Simple, easy to follow diagrams, photographs and comparative tables of stainless steels to various media are also included. *Allegheny Ludlum Steel Corporation.*

Circle number (58) on reply card.

Industrial Insulation

A practical handbook for the field worker in industrial insulation has been compiled. It presents — in as practical and simple a way possible — solutions to a few of the daily field problems. Insulation foreman and maintenance superintendent will be especially interested in it. *The Aber Company.*

Circle number (59) on reply card.

Gas Purification Process

Performance data and photographs of typical industrial applications of this gas purification process are outlined in a new booklet just made available. Applications listed for this process include natural gas, refinery gas, synthesis gas, hydrogen sulfide recovery and many others. Chemistry and basic flow diagrams of the process are presented. *Girdler Construction Division — Chemetron Corporation.*

Circle number (60) on reply card.

Manual On $NaBH_4$ & KBH_4

New 34-page manual of techniques covering the properties, reactions and handling requirements of sodium and potassium borohydrides is available. Included in the manual are detailed discussions of reactions in aqueous and non-aqueous solvents. Technical data compiled from the most significant works published to date is presented in 13 convenient tables. *Metal Hydrides Incorporated.*

Circle number (61) on reply card.

Corrosion Resistant Plastic

Bulletin describes selection of the proper plastic for each and every chemical corrosion problem. Various fields of application are covered concisely and thoroughly with tables, pictures, diagrams and descriptions. Manufacturer says that it will enable engineers to select and specify correct corrosion resistant plastic equipment to meet any situation. *Haveg Industries, Inc.*

Circle number (62) on reply card.

Thermocouple Data

New engineering data bulletin describes the applications, advantages and materials of construction of furnace tube wall thermocouples. Manufacturer states that installation time and costs have been cut up to 75 percent. Diagrams and a data sheet are included. *Thermo Electric Company, Inc.*

Circle number (63) on reply card.

Polyethylene Cable Lacing

Bulletin describes spirally-cut, noncombustible polyethylene cable lacing and how it is applied by means of a simple wiring tool. Lacing will secure any number of wires in cables from ¼ in. to 4 in. in diameter. It is reusable and said to give excellent service over a wide temperature range. Bulletin lists complete electrical and physical specifications. *Panduit Corporation.*

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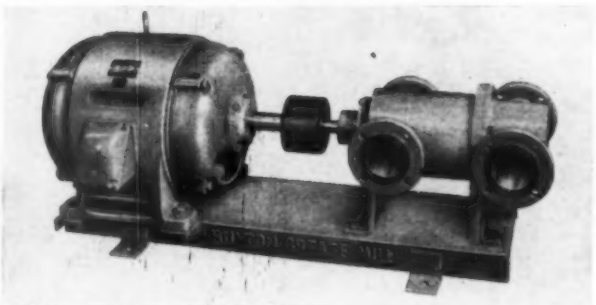

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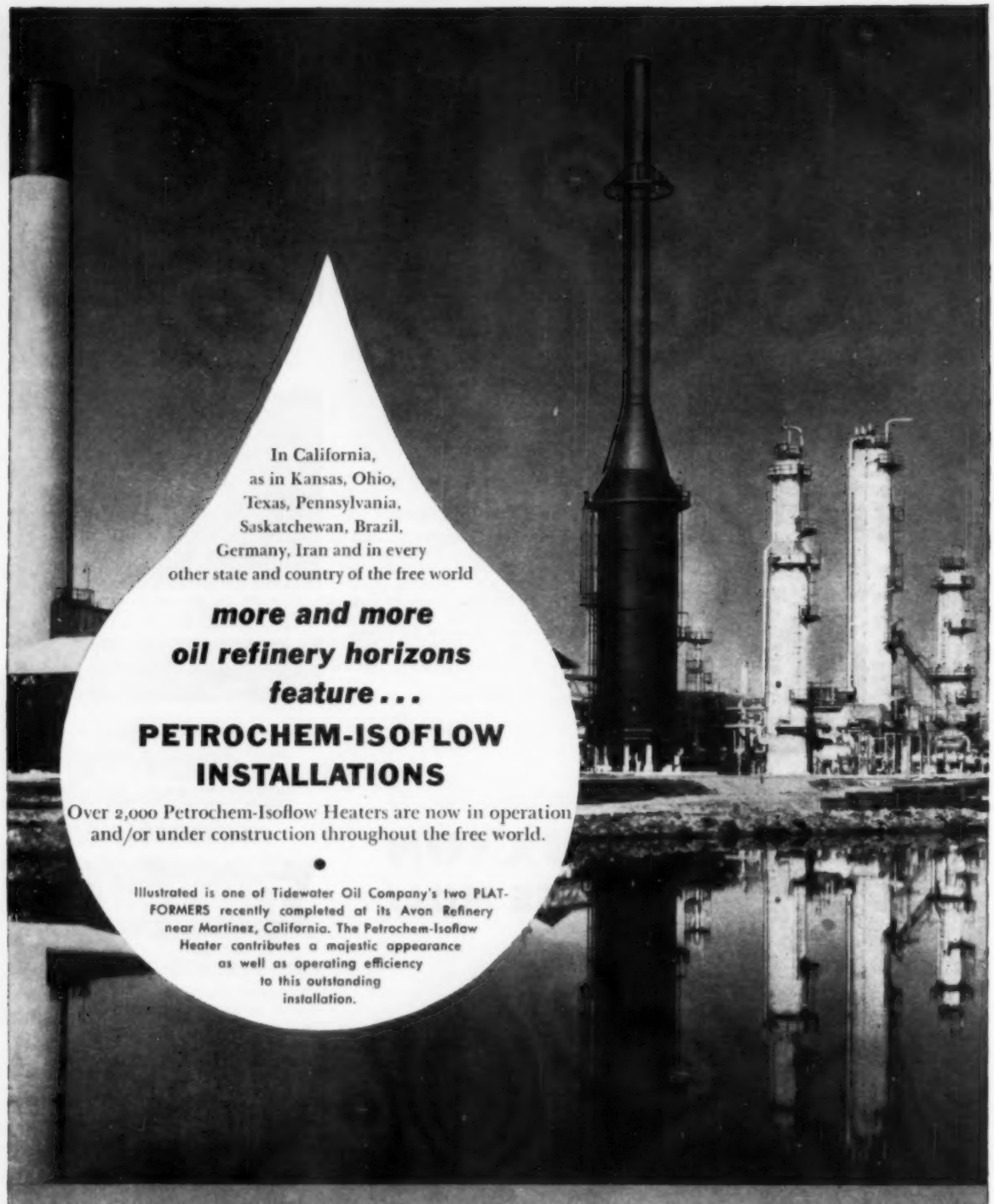

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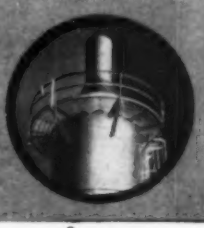


the Pipeline Engineer

Oil..Gas Products Pipelining

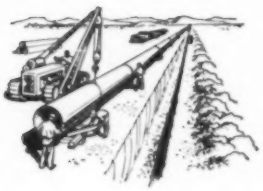
DURIRON

ANODE DATA SHEET

Number **2** Ground Bed

Basic engineering information about DURIRON *impressed current anodes for cathodic protection.*

Protection of a Pipe Line



THE PROBLEM: To protect a pipe line in a creek bed area where coke breeze could not be used due to sandy top soil and quicksand at a four foot depth. The very nature of sandy soil prevents adequate backfilling because it is very prone to caving. The original ground bed of bare scrap iron anodes had a high resistance and showed a tendency to dry out during the year. Adequate protection of the pipe line was not being achieved.

THE INSTALLATION: Twenty Duriron Type D Anodes (2″ dia. x 60″) were installed in two rows, 20 feet apart, with 20 foot spacing in each row as illustrated in Fig. 1. Soil resistivity averaged 2500 ohm-centimeters measured with the four pin method at 10 foot spacing. The anodes were jetted into place using a high velocity stream of water through a 10 foot piece of 1 inch pipe with the top of each anode eventually being approximately three feet below the surface (Fig. 2). Approximately 60 seconds were required to install each anode by this method. The anodes were connected to a 2/0 aluminum header, with the exception of numbers 4, 6, 16, and 17 which were connected to separate number 6 leads and were carried back to the rectifier and connected thereto with 0.01 ohm Holloway shunts. This made possible the reading of individual current values for these four anodes. The connection to the pipe line was by means of an overhead 4/0 copper cable, a distance of about 1000 feet.

THE PERFORMANCE TO DATE: This group of anodes produced 34 amperes (an average of 0.65 amp./sq. ft.) at 46 volts, and after approximately three year's time, these readings have not fluctuated appreciably. Based on initial readings, the resistance of single Type D anodes to ground is approximated by the expression $R=0.005\rho$. (R is the single anode resistance and ρ the soil resistivity in ohm-centimeters.) The loop resistance of sixteen anodes (all except the four with independent leads) was measured as 1.3 ohms; the four, together, read 3.9 ohms; and all twenty indicated 1.2 ohms. This indicates that Duriron anodes can be installed without backfill and operate at appreciable current densities with no noticeable tendency toward gas blocking. The jetting-in process used to install these Duriron anodes was reported to result in considerable savings. It would have been very difficult to install anodes in holes dug by the usual rotary drill method under the ground conditions described above, and it would also have been expensive to transport backfill to this relatively inaccessible locality.

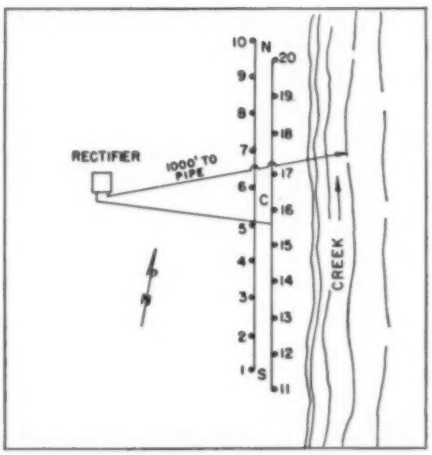


FIG. 1—Illustration of how Duriron Anodes were spaced.

FIG. 2—Illustration of jetting in process.

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Now you can integrate the flow of all process fluids or plant services *continuously* . . . with new accuracy . . . complete safety! The all-pneumatic Foxboro Flyball Integrator completely eliminates intermittent counting and fire hazard. Its simple, force-balance operation utilizes the 3-15 psi air signal from any conventional differential-pressure flow transmitter. This signal is *continuously* balanced against the "flyball" force of the instrument's pneumatically-driven turbine. The square root function is automatically extracted . . . you read flow totals *directly*.

The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. **The Foxboro Company, 389 Norfolk St., Foxboro, Mass.**

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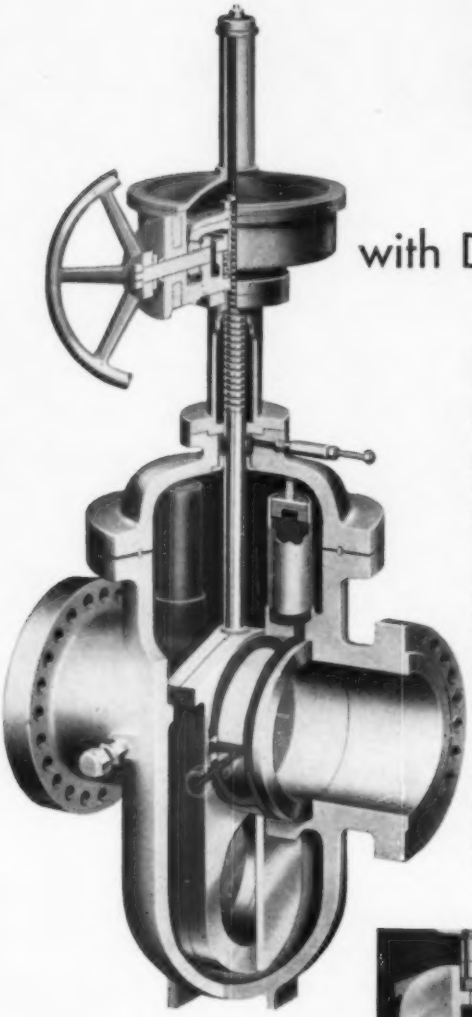
with DARLING-McEVOY Conduit Valves



Above: *Cutaway showing heavy, self-aligning gate and parallel seat assembly, with one of the two sealing systems indicated.*

Compare these features with *any* other pipe line gate valve:

1. **EVERY CLOSURE LEAK-PROOF.** No forcing. Positive automatic self-sealing under line pressure between seats and gate and between seats and body by means of sealing compound.

2. **NON-DIRECTIONAL.** Flow may be in either direction. Sealant cylinders operate independently.

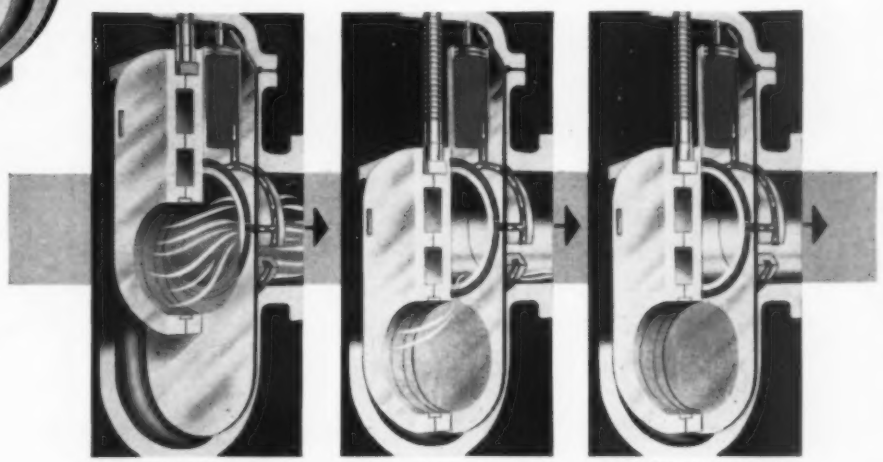
3. **TWIN SEALANT RESERVOIRS.** One for each port. Sealant feeds automatically to downstream side only.

4. **NEGLIGIBLE SERVICING.** Leak-proof closure requires very little sealant. Reservoir capacity ample for 50 to 80 operations dependent on differential pressures.

5. **SMOOTH, FULL FLOW.** No impediments. No turbulence. No pockets to collect sediment.

6. **EXCEPTIONAL PERFORMANCE AND LIFE.** Self-aligning gates. No wedging. Non-distorting seats, protected when valve is open or closed.

Darling-McEvoy conduit valves, made in 4" and larger sizes, are fully field proved and are now operating continuously on various major lines. For complete information on the self-sealing feature and many other advantages of this unique valve, ask for Bulletin 5402.



Right: *Diagrams of closure action on downstream side of gate.*

APPROACHING CLOSURE... *No loss of sealant as sealing groove in seat is disconnected from reservoir until gate is fully closed.*

CLOSED... *Jumper in gate now permits differential pressure to feed sealant into seat groove to check any remaining flow.*

AUTOMATICALLY SEALED. *Pressures again in balance. Tightness established. No additional sealant used until again needed.*

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DARLING VALVE & MANUFACTURING COMPANY

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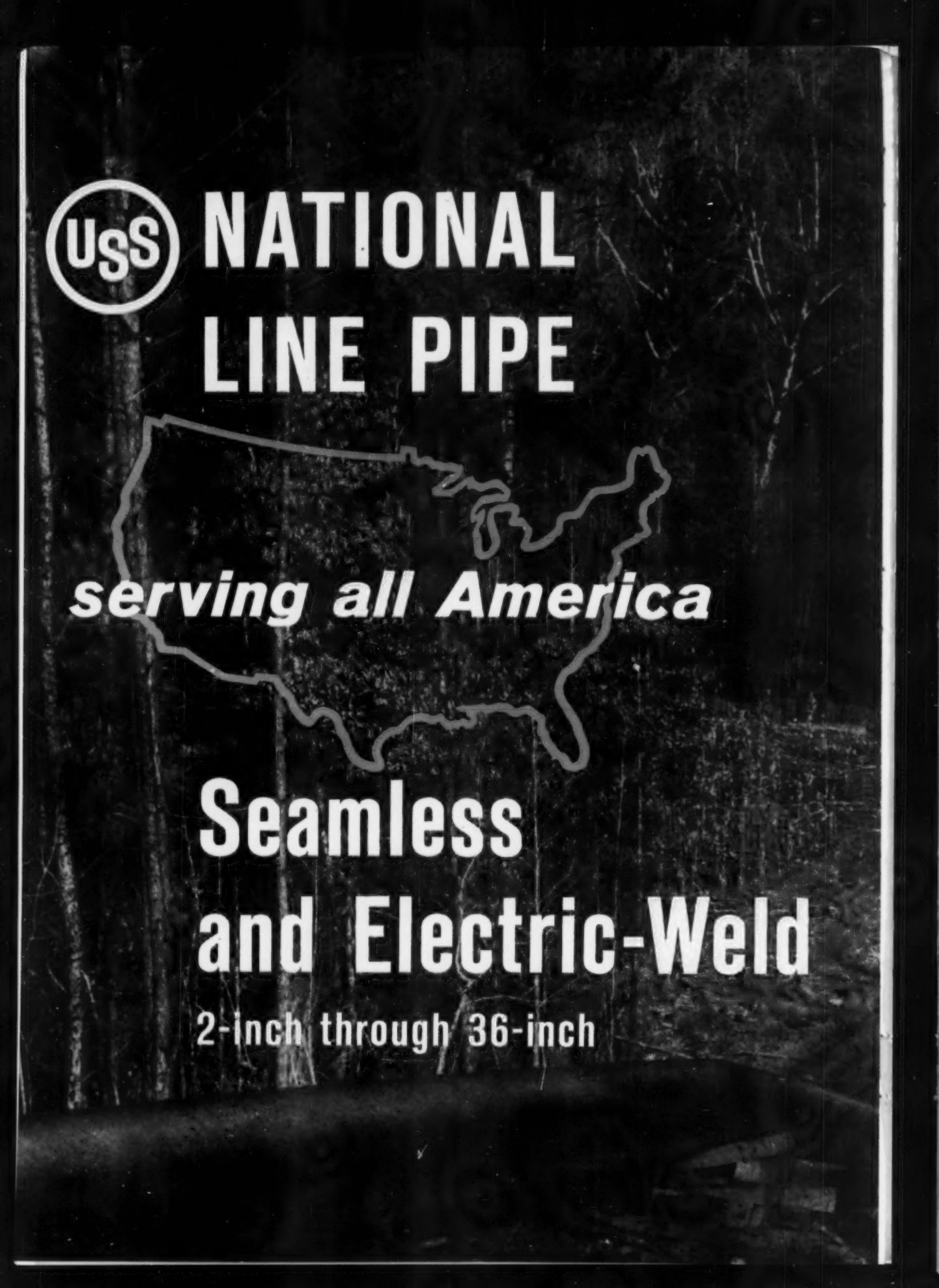
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario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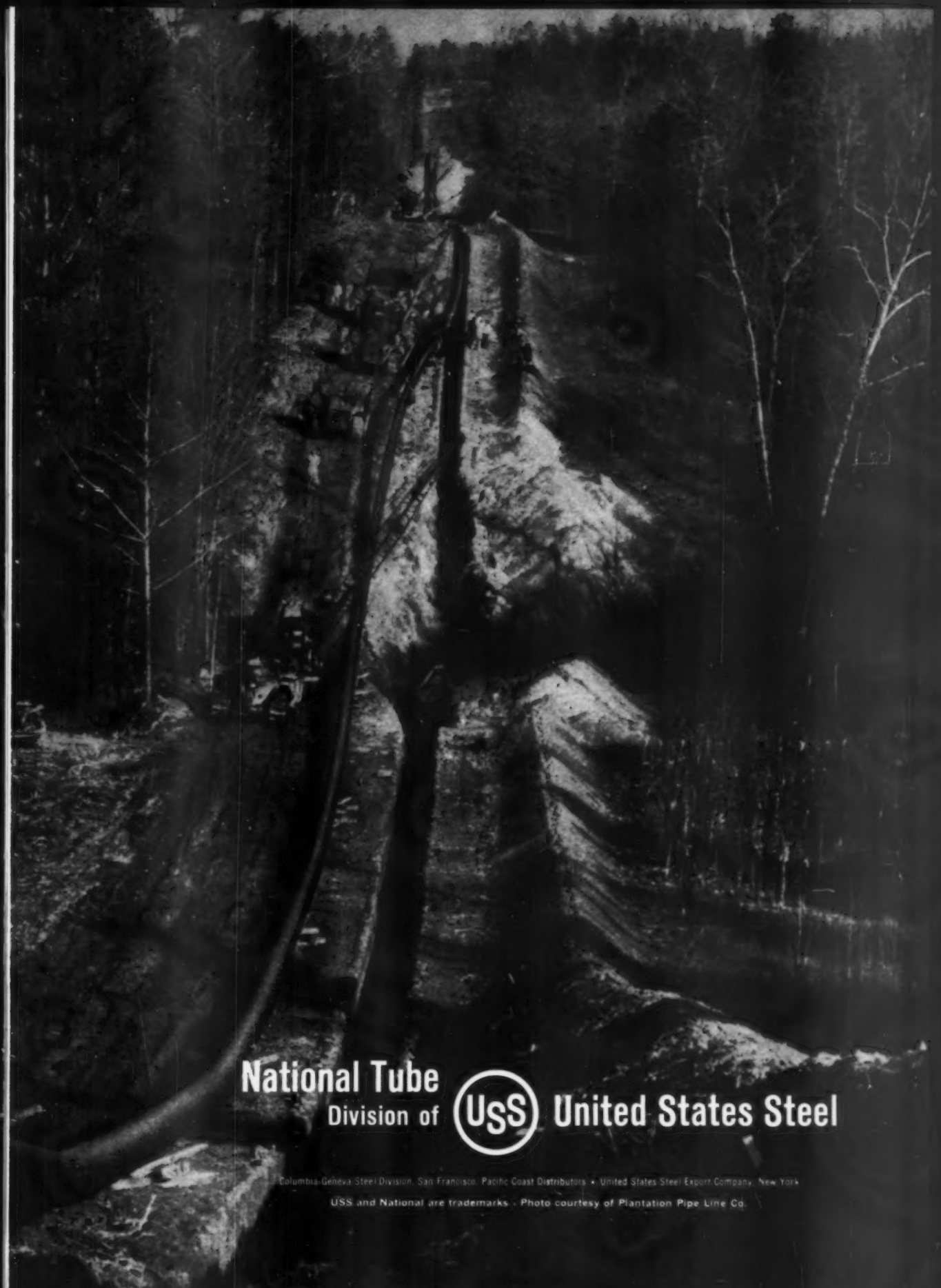

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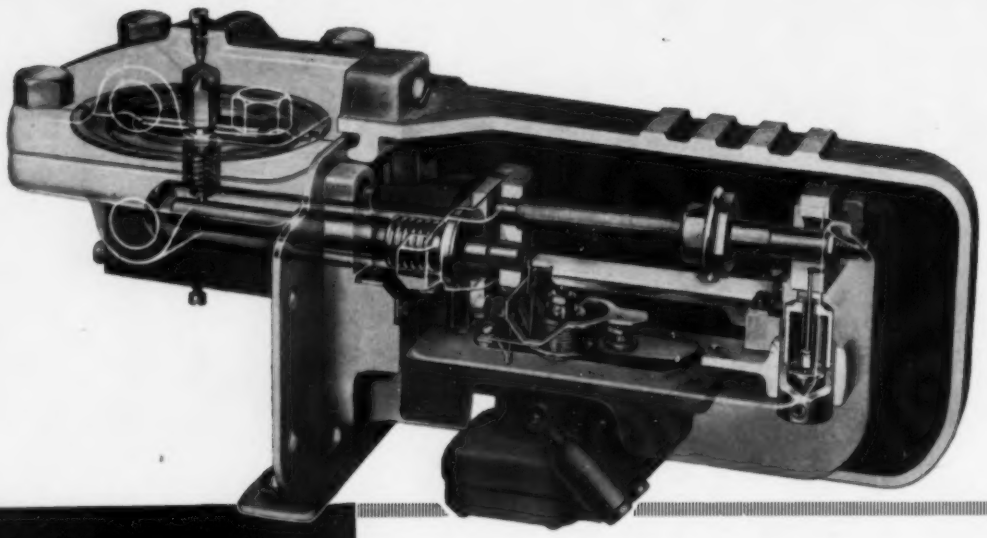

For full-range control of flow and liquid level

...there are now three HONEYWELL *Differential Converter* models

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2. *For measuring liquid level in closed tanks:* One model has a range of 14 to 50 inches of water, with maximum suppression of 75 inches. Another model, with a range of 50 to 200 inches of water, has maximum suppression of 200 inches.
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A mercuryless remote pneumatic transmitter with a range that is continuously adjustable between 0-5 and 0-25 inches of water has just been added to the Honeywell *Differential Converter* line. Now you can choose a standard transmitter for any range from 0-5 to 0-1000 inches of water . . . a choice of ranges offered by no other manufacturer.

The *Differential Converter* measures gas and liquid flow or liquid level with accuracy within ±1% . . . and with rapid response, upscale and down. Range is continuously adjustable in the field, without parts change, and field calibration check is easily accomplished with weights. Air consumption is extremely low.

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MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Bulletin 2298-1, "*Differential Converter* Liquid Level Transmitter"; Catalog 2321, "Flow Meters," and Specification 248, "*Differential Converter* Flow Transmitter."

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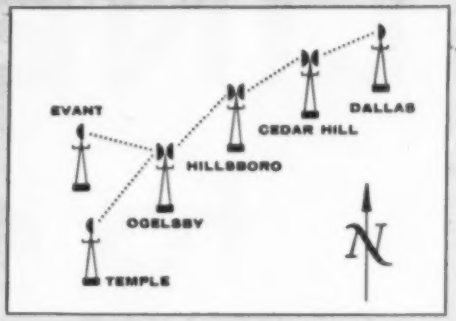

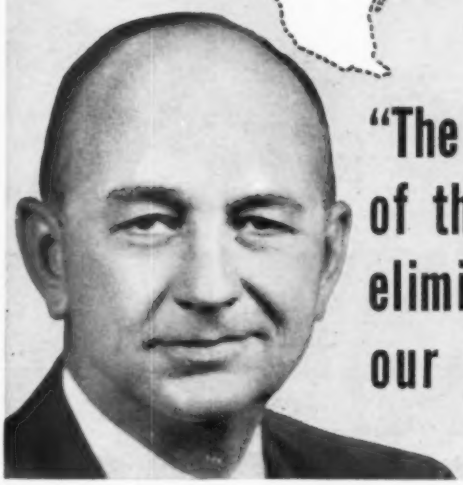

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M. S. Collett, *Manager Communications*
Atlantic Refining Company

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The baseband amplifier in this RCA system provides a broad band from 300 cycles to 500,000 cycles on which multiplexed circuits are placed. Channels may be interchanged simply by switching plug-in crystals. Channel units have the high stability required for frequency-shift telegraphy, telemetering, and facsimile. Multiplex circuits employ standard single sideband, suppressed carrier technique long accepted for efficient utilization of spectrum space. For further particulars on use of microwave in utilities, pipelines, turnpike and other applications . . .

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LINE PIPE to 42 in.

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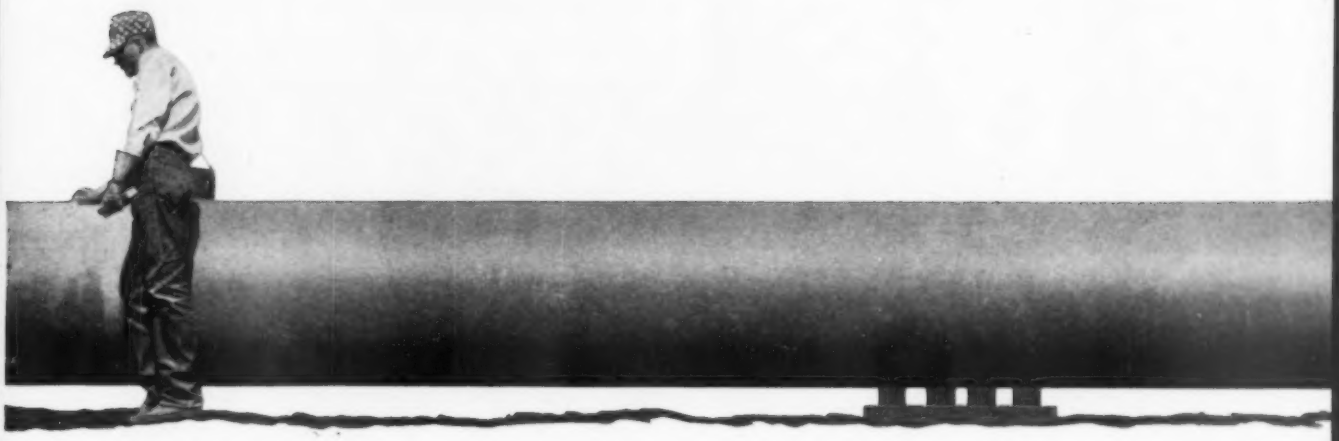

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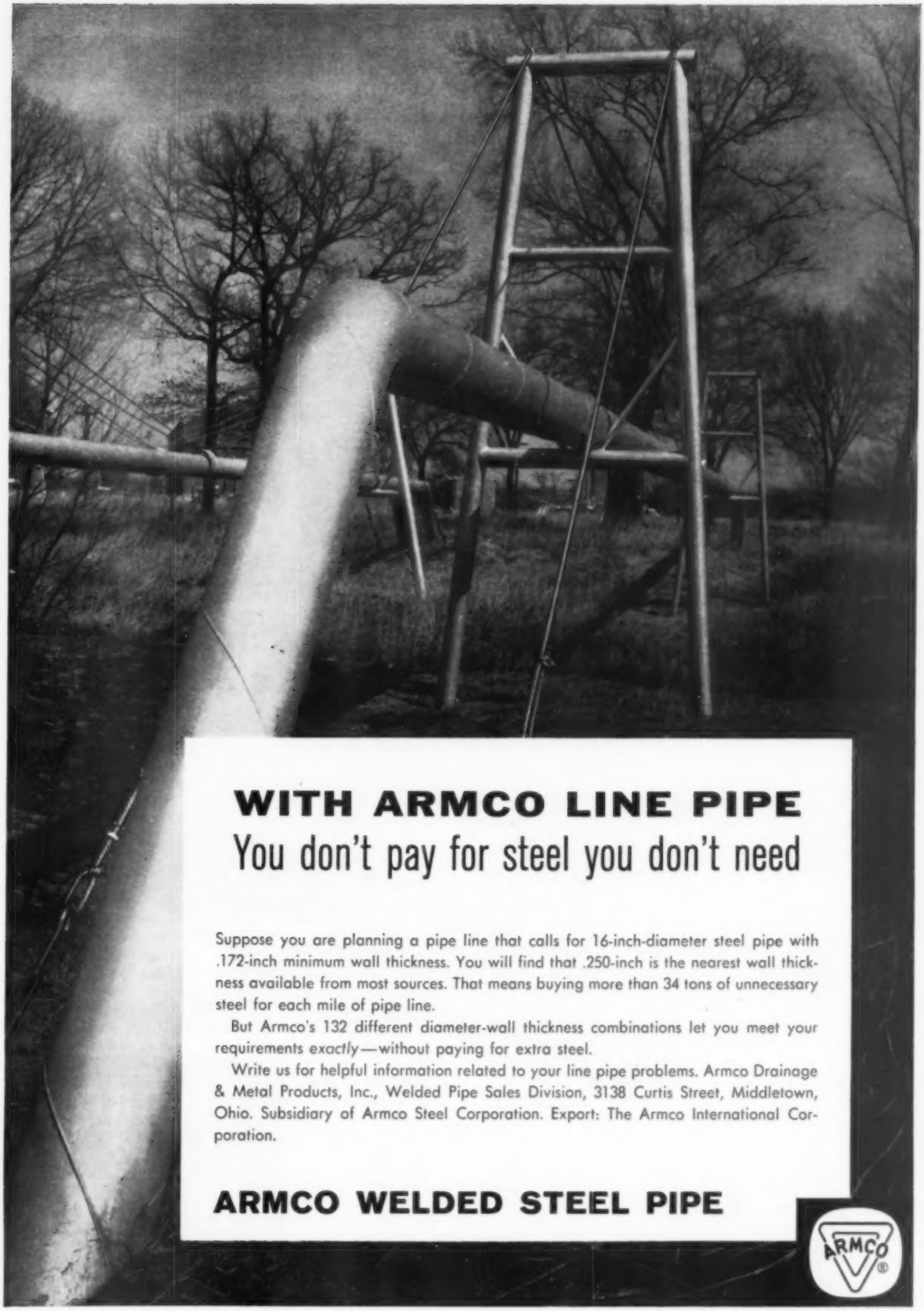

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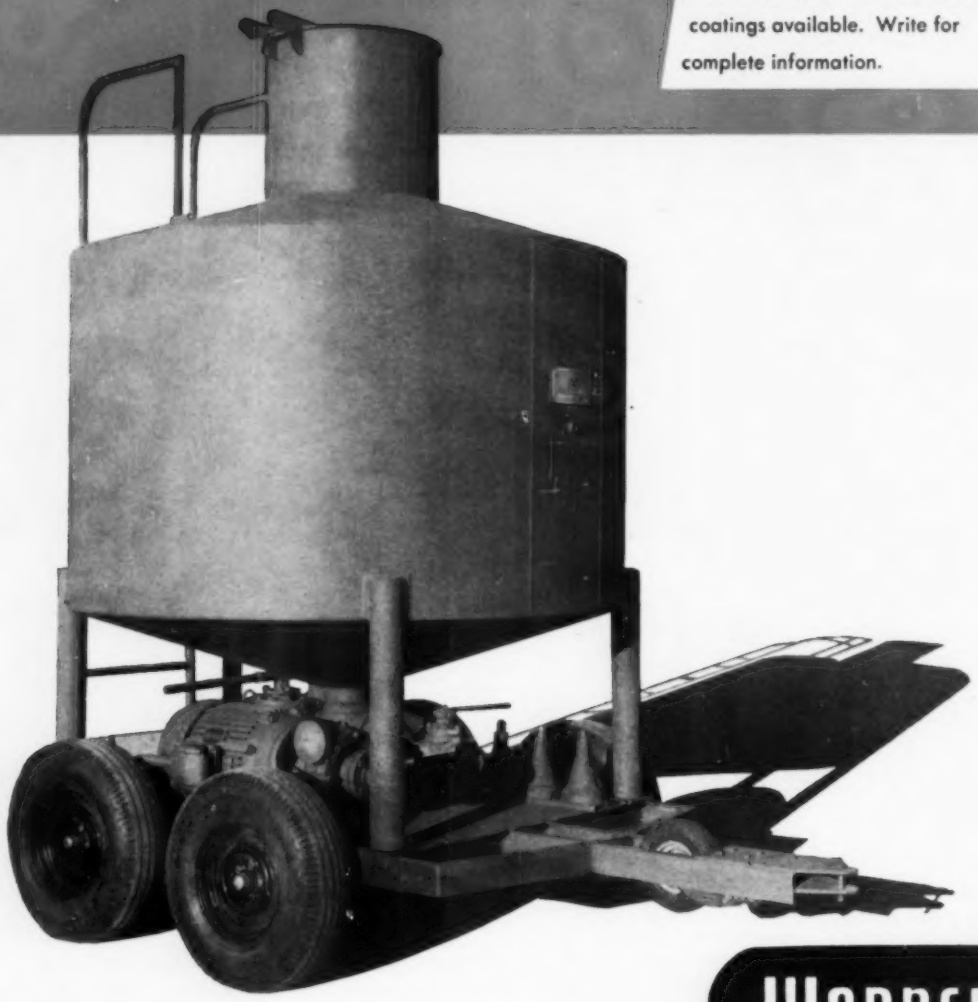

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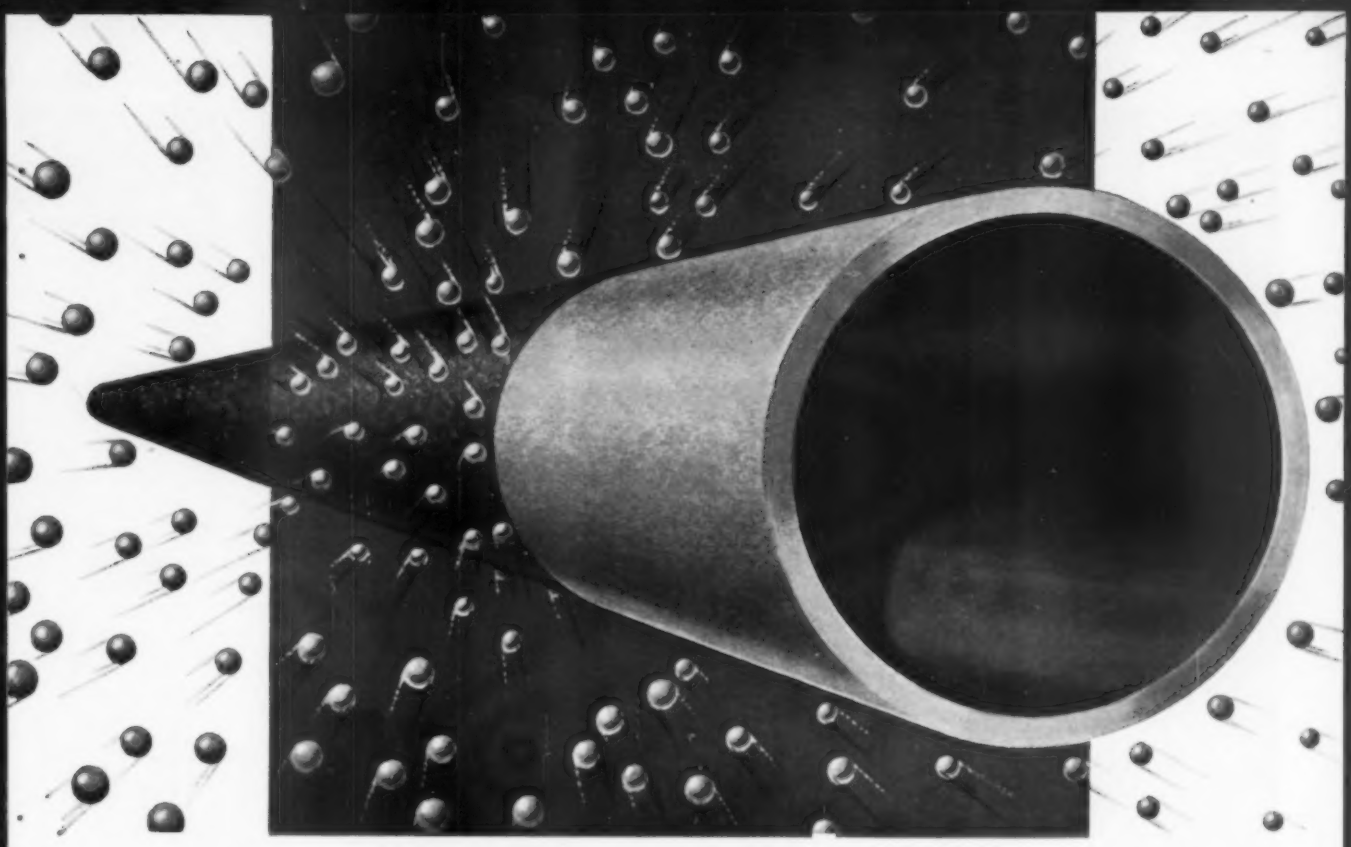

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Applying protective coatings to improperly prepared pipe surface makes about as much sense as building a skyscraper on sand. Pipe Line Service has always pioneered in developing new ways to insure a good bond . . . a bond that makes protective coatings practically inseparable from the pipe itself.

An outstanding example is steel shot cleaning. Special machines permit bombardment of the pipe surface with millions of steel pellets traveling at high speed. Result? Not simply removal of mill scale and rust . . . but actually an "etching" of the steel surface. This slightly roughened surface allows the protective coating to "take root"—gives you the years of protection that you should have.

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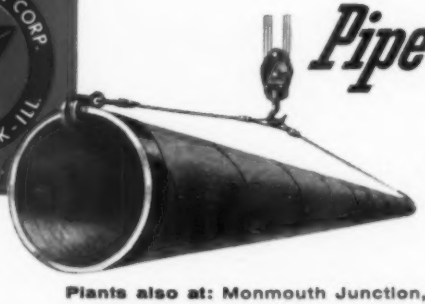

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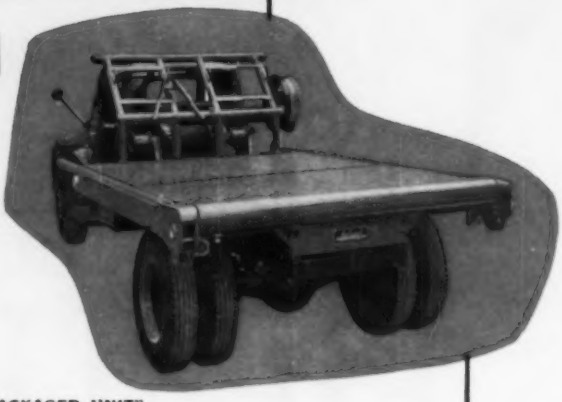

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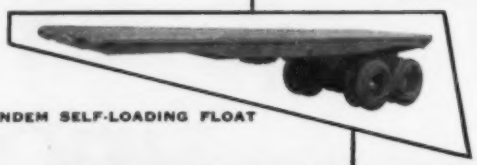
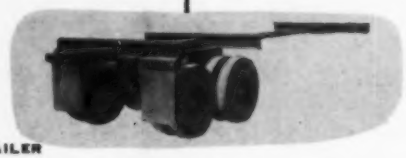


TANDEM SELF-LOADING FLOAT

POLE TRAILER



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PIPELINE CONSTRUCTION IS COMING BACK STRONG

Slowed by Memphis Decision and the recession, there are, nevertheless, 21,893 miles "Completed or Under Construction" and 23,085 miles "Planned or Proposed"

Frank H. Love, *Editor*

PIPELINE CONSTRUCTION is making a strong comeback from a slow beginning the early part of 1958, *The Pipeline Engineer's* annual survey reveals.

Operating companies in their reports covering the last 12 months provide these statistics:

- **Crude lines built or under construction ... 4950 miles**
- **Products lines built or under construction ... 2677 miles**
- **Gas lines built or under construction 14,266 miles**
- **Total all pipelines ... 21,893 miles**

A year ago when this survey was made these were the figures:

- **Crude oil lines built or under construction ... 4468 miles**
- **Products lines built or under construction ... 6245 miles**
- **Gas lines built or under construction 14,700 miles**
- **Total all pipelines ... 25,413 miles**

Thus, there is a difference of only 3520 miles, an excellent record in view of the deterring effect of the Memphis Case and the general business recession.

What of the future? Included in the statistical tables that are a part of this article is a section on "Proposed or Planned" pipelines. The total in this category is 45,022 miles; however, it should be understood that many of these lines will not be constructed during the next year. Nevertheless, they have been proposed and are listed to complete the record. Most of them will be built eventually, some likely will not.

A more realistic figure for the next 12-months' construction is 23,085 miles, broken down as follows:

- **Crude oil lines ... 6500 miles**
- **Products lines ... 1769 miles**
- **Gas lines ... 14,789 miles**

A year ago proposed and planned pipelines totaled 27,689 miles, divided in this manner:

- **Crude oil lines ... 8281 miles**
- **Products lines ... 6054 miles**
- **Gas lines ... 13,354 miles**

Gas Pipeline Construction

Construction of several important gas pipelines will start before the end of the year. Being watched most closely is the one originating in South Texas producing fields and terminating at Miami, taking natural gas to Florida for the first time. Overall, including main line, field laterals, distribution laterals, and gathering lines this system will consist of some 2600 miles of pipeline.

Coastal Transmission Corporation will build and operate the line from its originating point near McAllen in the Rio Grande Valley of Texas to Baton Rouge, Louisiana. Main transmission line will be 574 miles of 22 and 26-in. pipe, with some 414 miles of various size gathering lines.

Houston Texas Gas and Oil Corporation will construct and operate approximately 943 miles of 12 to 30-in. pipeline, which will include the main 30-in. trunk to Miami and laterals to serve Florida distributors and industrial users.

Both companies are subsidiaries of The Houston Corporation.

This project has been in the planning stage for well over a year and has met with resistance along the way. Opposition came from the Florida Economic Advisory Council, composed of fuel oil marketers and transporters, who eventually asked the U. S. Supreme Court to review the Federal Power Commission's approval of the line. The Supreme Court refused, however, thus clearing the last legal obstacle.

Transwestern Pipeline Company with headquarters in Houston, Texas, is before the Federal Power Commission with a proposal to lay a pipeline system in excess of 1300 miles in length. The main line will be from Roswell, New Mexico, to Topock, Arizona, where gas will be delivered into the system of Pacific Lighting Gas Supply Company, which will build a 128-mile, 34-in. line from Needles to Newberry, California, to handle the gas.

The Roswell-Topock part of the system will be approximately 670 miles of 30-in. Two main 24-in. laterals will converge at Roswell. One of these lines will originate in West Texas gas fields, the other in the Texas-Oklahoma Panhandle. Total length of the two laterals will be about 635 miles.

Trunkline Gas Company of Houston has applications pending before FPC for a total of 823 miles of pipeline. Of this, 508 miles are loops and 111 miles gathering lines. The remainder is a 204-mile, 26-in. extension of its main line from central Illinois to the Indiana-Michigan border where it will connect with the Consumers Power Company system, one of Michigan's largest distributors of natural gas.

Biggest project of Natural Gas Pipeline Company of America at the moment is 493 miles of 36-in. and 20 miles of 26-in., being laid as loops between Fritch, Texas, and Joliet, Illinois. Cost of these lines, together with metering facilities, will run to $81,840,000.

FPC willing, Tennessee Gas Transmission Company will spend $169,300,000 on 1072 miles of pipeline and 104,250 hp in compressor capacity. This proposal is not related to that of Midwestern Gas Transmission Company, a subsidiary, it is emphasized, but will consist of loops along its system. Close to another $3,000,000 would be spent under a proposal to lay 21 miles of 16-in. and 2 miles of 12-in. to Blocks 46 and 64, offshore from Louisiana.

Gulf Interstate Gas Company has received final authorization for 351 miles of 30-in. main line between Louisiana and Kentucky, and 54 miles of 24-in. laterals in Louisiana. The new facilities will increase the system's maximum winter capacity to 666,100,000 cu ft a day.

Latest certificate issued to Southern Natural Gas Company authorized ap-

proximately 360 miles of pipeline in southern Louisiana, 4310 hp in compressor capacity, and 23 measuring stations. These facilities, together with others authorized earlier, will increase Southern Natural's south Louisiana supply system by 298,030,000 cu ft a day.

Transcontinental Gas Pipe Line Corporation has been active in construction loops and purchase laterals, and has a big program coming up, for which FPC approval is being awaited. Included are 363 miles of 30 and 36-in. loops in Texas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Pennsylvania, and New Jersey; 496 miles of 20-in. and less purchase laterals in Louisiana, and 193 miles of 23 and 30-in. underground storage lines in Pennsylvania.

Colorado Interstate Gas Company is one of the companies that postponed its plans after the Memphis decision. Now ready to go ahead, this company is awaiting approval of FPC for 682 miles of new and loop lines, most of which are 24, 26, 30, and 34 in.

Northern Natural Gas Company has considerably more construction planned than it undertook in late 1957 and early 1958. Projected are 408 miles of loops and new lines in sizes ranging from 16 to 30 in.

Pacific Gas and Electric Company has underway 163 miles of 12-in. high pressure line between Corning and Eureka, California, and completed in May 138 miles of 34-in. between Topock, Arizona, and Milpitas, California. More work is planned between Topock and Milpitas. Triple loops will be laid at two locations, totaling 132 miles of 34-in.

Canada has had another good year with most of the construction being gas pipelines. Foremost among these is the Trans-Canada Pipe Line, which is expected to be completed and gas flowing through it by November 1. Details on Canadian construction is covered in a separate article in this issue.

Foreign pipelining has taken on greater impetus. Under construction in France is Gaz de France's 1000-mile pipeline. The system originates in the Lacq field and extends from there to Paris, 550 miles of 16 and 24-in. Laterals to Nantes and Lyons add another 450 miles. On these laterals 10, 12, and 16-in. pipe is being used.

The Soviet Union asserts it has 2087 miles of gas lines under construction, mostly 32-in. pipe.

Sui Gas Transmission Company in Pakistan is planning to extend its Sui-Multan line on the Lyalpur, 130 miles. It will be a 16-in. line.

Crude Oil Pipelines

The Four Corners area, so called because it is located where the states of Utah, Colorado, New Mexico, and Arizona meet, was given two pipeline outlets this year. First to go into operation was Four Corners Pipe Line Company (April), owned by six companies but built and operated by Shell. This system extends 775 miles from producing areas of New Mexico and Utah to the Los Angeles refining area. The main line is 16 in., and initial capacity is 70,000 bbl a day.

Texas-New Mexico Pipe Line Company's system originates in the Aneth field, Utah, and terminates at Jal, New Mexico, where it connects with other pipelines to give Four Corners' crude a market in the Gulf Coast, Mid-Continent, and Chicago areas. The 16-in. line is 512 miles in length and has capacity for 50,000 bbl a day. This system was placed in service in July.

Jayhawk Pipe Line Corporation is nearing completion of its line to take southwestern Kansas crude to the Wichita area. The 242-mile, 10 and 12-in. line is laid from the Novinger field, Meade County, to Valley Center, north of Wichita.

Sinclair Pipe Line Company has completed the second segment of a two-part project that had its start in 1956. At that time 152 miles of 18-in. pipeline was laid from Jacksboro to Teague, Texas, replacing two smaller lines. The project recently completed involved construction of 149 miles of 20-in. from Teague to Houston, also replacing two smaller lines.

A major addition was made to its system by Humble Pipe Line Company. Completed in May was a 90-mile, 16-in. between Hawley, Jones County, Texas, and Comyn, Comanche County. It has a maximum capacity of 99,000 bbl a day and replaces a 10-in. line that had a capacity of 62,000 bbl a day.

Service Pipe Line Company is nearing completion of an expansion program to its system in Wyoming, Colorado, and Kansas. Included is 120 miles of pipeline, most of which is 20 in., and three new pump stations.

Magnolia Pipe Line Company has been active in enlarging its facilities. Late last year 131 miles of pipeline were laid and since the first of this year another 160 miles have been completed.

Shell Pipe Line Corporation is planning a 120-mile line in combination sizes from 8 to 20 in. from the Mississippi River Delta area to the New Orleans refining area.

Of international flavor is the proposal to build a 1500-mile pipeline system from Edmonton, Alberta, Canada, to the Chicago area. Mid-Continent Pipelines, Ltd., has applied to the Canadian Board of Transport Commissioners for permission to build the 600-mile Canadian section to the international boundary at Northgate, Manitoba. An American subsidiary, International Oil Pipeline Corporation, with headquarters in New York, has been organized to construct and operate the 900-mile section terminating at Joliet, Illinois.

Products Pipelines

Laurel Pipe Line Company, a new organization with headquarters in Harrisburg, Pennsylvania, has launched a major products pipeline project. The 440-mile line will transport gasoline and other petroleum products from refineries in the Philadelphia area to Cleveland, Ohio, and intermediate points. It will be 24 in. in diam on the eastern section, which comprises about a fourth of the entire system, the remainder varying in diameter from 14 to 20 in.

West Emerald Pipe Line Corporation, Amarillo, Texas, an affiliate of Shamrock Oil and Gas Corporation, expects to complete in late fall the 290-mile, 6-in. project it has underway between Amarillo and Albuquerque, New Mexico. There will be terminal outlets at Tucumcari and Albuquerque.

Wabash Pipe Line Company was organized by Ohio Oil and Continental to build and operate 350 miles of 12-in. pipeline in Illinois and Indiana. The 85-mile section from Robinson to Champaign, Illinois, was completed in May. The 265-mile section from Wood River, Illinois, to Griffith, Indiana, got underway in August and will be completed early in November.

The Little Big Inch Division of Texas Eastern Transmission Corporation completed in January of this year 233 miles of 14-in. as an extension of its products system, which was formed basically by conversion of the Little Big Inch from gas service. Planned now is a 62-mile, 8-in. line from Tyler to Carthage, Texas, and a 10-mile, 8-in. from Lebanon, Ohio, to the Todhunter storage field, the latter an LPG line.

Cherokee Pipe Line Company has been converting a crude oil line to products service between Glenpool, Oklahoma, and Wood River, Illinois, and expects to have the job done by September 1. This is a 10-in. line 398 miles in length. As a part of the system 75 miles of 12-in. between Ponca City and Glenpool and 12 miles of 12-in. from Glenpool to Tulsa were completed in July.

Great Lakes Pipe Line Company has completed in the last 12 months a total of 270 miles of new 8-in., 104 miles of 8 and 12-in. loops, and 14 miles of 8-in. as replacement.

A complete tabulation of pipelines "Proposed or Planned" and "Built or Underway" is given in the following tables.

Proposed or Planned Pipelines

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils Toronto, Ontario, Canada	450		Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Afrique du Nord Development Societe	850	18	Hassi-Messaoud field, Algeria, to Mediterranean port
Alaska-Yukon Pipe Lines Inc. Anchorage, Alaska	618	—	Valdez to Tok Junction, Alaska, and Kenai to Anchorage
Arabian American Oil Co. D'hahran, Saudi Arabia	164	30-32	Loops and extensions
Argentine Government (YPF) Buenos Aires, Argentina	450	14	Neuquen Provinca to Bahia Blanca
Assam Oil Co London, England	600	20	Upper Assam to Barauni
Bituminous Oil Pipeline Ltd. Calgary, Alberta, Canada	250	—	McMurray to Edmonton, Canada
Bolivian Government (YPFB) La Paz, Bolivia	215	8, 10	Sicasica, Bolivia, to Arica, Chile
Burmah Oil Co. Ltd. Glasgow, Scotland	250	20	Barauni to Calcutta
Cape Pipe Line Co. Philadelphia, Pennsylvania	200	—	Large diameter from Delaware Bay to Greater Philadelphia area refineries
Creole Petroleum Corp. Caracas, Venezuela	86	30	Temblador field to Caripito, Venezuela
Elburz Oil Co.	1000	38	Qum, Iran, to Alexandretta, Turkey
Federated Pipe Lines Ltd. Calgary, Alberta, Canada	125	10	Swan Hills field to Edmonton
Gillette Pipeline Inc. and A. W. Hartwig Inc.	102	—	Dead Horse Creek field to Casper, Wyoming
Great Northern Railway Co. St. Paul, Minnesota	600	12-20	Williston Basin to St. Paul-Duluth-Superior, Wisconsin-Minnesota area
Independent Pipe Line Co. Calgary, Alberta, Canada	2019	34-36	Edmonton to Montreal
International Oil Pipeline Corp. New York, N. Y.	900	30	International boundary near North Gate, Saskatchewan to Chicago area (continuation of Mid-Continental line)
Iraq Petroleum Co. London, England	Approx. 600	—	Kirkuk field to Iskenderun, Turkey
Jayhawk Pipe Line Corp. Wichita, Kansas	140	6	Feeder lines to Interstate field, Morton County, Kansas, and Pleasant Prairie field, Haskell County
Mid-Continent Pipe Line Co. Tulsa, Oklahoma	3	10	Replacement from Duncan to Palacine
Mid-Continent Pipelines Ltd. Edmonton, Alberta, Canada	600	30	Edmonton, Alberta to U. S. boundary near North Gate, Saskatchewan
Offshore Gathering Co. Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Oil Field Pipe Line Inc. and Panhandle Eastern Pipe Line Co. Kansas City, Missouri	200	8, 12	Elkhart to Ellinwood, Kansas
Peace River Oil Pipeline Co. Calgary, Alberta, Canada	75	6, 8, 12	Swan Hills field to Burgun Junction
Royal Pipe Lines Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Shell Pipe Line Corp. Houston, Texas	119.7	8, 12, 16, 20	Mississippi River Delta area to New Orleans refining area
	63	4, 6, 8	Colorado City, Texas, to Borden-Garza County area, West Texas
Southern Kansas Pipe Line Co. Arkansas City, Kansas	310	6, 10	Greenwood pool, near Colorado line, thru Liberal to Arkansas City, Kansas
Ste. Petroliere de Gerancie (subsidiary Cie. Francaise de Petroles) Paris, France	300	24	Messaoud field in Sahara Desert to Bougie, Algeria, on Mediterranean coast
Trans-Border Pipe Line Co.	110	—	Skagway, Alaska, to Whitehorse, Yukon Territory
Trans-Prairie Pipelines Ltd. Edmonton, Alberta, Canada	15 3 2	4, 6 3, 4 3, 4	Weyburn field gathering lines Virden Roselea gathering lines Routledge gathering lines
Union Oil Company of California Los Angeles, California	5 9	12 8	New line from San Pedro, California Replacement from Shandon to Antelope
West Coast Pipeline Co.	960	20-22	Wink, Texas, to Norwalk, California
17 American, English, French and Dutch Companies	1500	38-40	Middle East producing areas to Mediterranean Coast in Turkey
Yacimientos Petroliferos Fiscales Buenos Aires, Argentina	434	—	Challaco, Neuquen Province, to Arroyo Parejas

PRODUCT LINES

Name of Company	Miles	Size	Location
American Pipe Line Co. New York, New York	1910	8-26	Beaumont, Texas, to Newark, New Jersey
Argentine Government (YPF) Buenos Aires, Argentina	650	10	Lujan de Cuyo refinery in Mendoza Province to Buenos Aires area
Foothills Products Pipe Line Ltd. Edmonton, Alberta, Canada	500	12-16	Alberta to lower British Columbia
Hydrocarbons Pipelines Ltd. Winnipeg, Manitoba, Canada	800	6-8	Edmonton, Alberta, to Fort William, Ontario
Iran Oil Co. Teheran, Iran	209	6, 8	Ray to Rescht
M. K. & T. and New York Central Railroads	2500	—	Houston-Kansas City-St. Louis-Indianapolis-Cleveland-Syracuse, New York, with branches to Chicago and Detroit
Mene Grande Oil Co. Caracas, Venezuela	60	6	Anaco to Puerto La Cruz, Venezuela
Northwest Pipeline Corp. Salt Lake City, Utah	350	8-10	Four Corners to Salt Lake City, Utah
Texas Eastern Transmission Corp. Shreveport, Louisiana	10	8	Lebanon, Ohio, to Todhunter Storage field
	62	8	Tyler to Carthage, Texas
Underground Storage and Exploration Inc. Upper Darby, Pennsylvania	393	6, 8, 12	Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia
Union Oil Company of California Los Angeles, California	815	—	Shale oil plant, Rifle, Colorado, to Los Angeles area
	5	12	San Pedro, California
	9	8	Shandon to Antelope
Winnipeg & Central Gas Co. Winnipeg, Manitoba, Canada	210	6	U. S. Canadian border to Winnipeg

GAS LINES

Name of Company	Miles	Size	Location
Alberta Gas Trunk Line Ltd. Calgary, Alberta, Canada	111.4	24	Cessford to Nevis
	52	18	Nevis to Rimbey
	20	8	Duchess lateral
	8	6⅝	Countless lateral
American Louisiana Pipe Line Co. Detroit, Michigan	28	12	Gathering lines, Big Lake field
Andes Pipeline Corp.	500	12	Villamontes, Bolivia, to Antofogasta, Chile
Argentine Government (YPF) Buenos Aires, Argentina	1100	24	Campo Duran fields to Buenos Aires
Arkansas Louisiana Gas Co. Shreveport, Louisiana	300	—	Main and gathering lines Louisiana-Texas Gulf Coast
Chicago District Pipeline Co. Chicago, Illinois	50	36	Joliet, Illinois, to Chicago
	2	30	
Coastal States Gas Producing Co. Corpus Christi, Texas	45	2-10	Bee County, Texas
Coastal Transmission Corp. Dallas, Texas	574	22-26	McAllen, Texas to Baton Rouge, Louisiana
	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Co. Colorado Springs, Colorado	140	34	Salt Lake City, Utah, to Rock Springs, Wyoming
	215	26-34	Loop, Fourway, Texas, to Kit Carson, Colorado
	12	24	Bivins to Fourway, Texas
	100	24	Springfield to Pueblo, Colorado
	10	16	Keyes field, Oklahoma, to main line
Commonwealth Natural Gas Corp. Richmond, Virginia	12.5	18	Loop, Chester to Petersburg, Virginia
Consumers Gas Co. Toronto, Ontario, Canada	45	4	Bondhead to Beaverton
	28	4	Bondhead to Alliston
	24	4	Unionville to Uxbridge
Consumers Power Co. Jackson, Michigan	40	24	Woodbury to Laingsburg Junction
Cuban Gas Transmission Co. (Edwin Pauley) Los Angeles, California	1000	—	Mexico to Florida via Cuba
Eastern Shore Natural Gas Co. Salisbury, Maryland	124	6, 8	Transmission line and facilities in Delaware and Maryland
Edison Securities Company Los Angeles, California	130	—	San Joaquin Valley to Los Angeles
El Paso Natural Gas Co. El Paso, Texas	74	10	Loop, 26" and 30" California M/L to Yuma, Arizona
	14.1	30	Loop, Keystone plant westward
	75.9	16, 20	Aneth, Utah, plant to S. J. River discharge line
	400	34	Salt Lake City, Utah, to California-Nevada border Southwest of Las Vegas
Gulf Interstate Gas Co. Houston, Texas	23.20	6-12	New line, various fields in South Louisiana
	25.30	24	Loop, station 10 east
	28.70	24	Loop, station 10 west
	351.7	30	Main line loop between Louisiana and Kentucky
Gulf Resources Inc. New York, N. Y.	125	—	Lines and gathering system from Lopena (Zapata County, Texas) area to point in La Salle County, Texas
Houston Texas Gas & Oil Co. Houston, Texas	942.6	12-30	Baton Rouge, Louisiana to Miami, Florida Laterals to serve Florida distributors and industrial users
Humble Oil and Refining Co. Houston, Texas	250	30-36	Southwest Texas (King Ranch) to connection with Clear Lake-Port Arthur line
Iron Ranges Natural Gas Co.	120	6, 12	Mesabi Iron Range to northern Minnesota
	63	12	North Shore of Lake Superior
Kentucky Gas Transmission Corp. Charleston, West Virginia	20.5	26	To parallel existing lines in Bracken County, Kentucky

GAS LINES

Name of Company	Miles	Size	Location
Lone Star Gas Co.	22.45	20	Loop, Trinidad, Texas, north
Dallas, Texas	8.50	6⅝	New line, Freestone County, Texas
	11.51	12¾	Replacement, Haskell County, Texas
	14.04	12¾	Replacement, Taylor County, Texas
	9.68	8	Replacement, Wilbarger County, Texas
	12	6⅝	Loop, Knox and Baylor counties, Texas
	11.63	6⅝	New line, Williamson County, Texas
Michigan Gas Storage Co.	40	26	Gratiot County to Isabella County
Jackson, Michigan			
Michigan Wisconsin Pipe Line Co.	56	20	Lateral from main line to Laverne field
Detroit, Michigan	20.5	22	Loop to Austin storage field, Michigan
	46	4-12	Laverne field, Oklahoma, gathering system
Midwestern Gas Transmission Co.	2067	3-24	Main line from U. S.-Canadian border near Emerson, Manitoba—Noyes, Minnesota, to Portland, Tennessee. Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin.
Houston, Texas			
Mississippi River Fuel Gas Corp.	37	26	Loop, Perryville, Louisiana, to Newport, Arkansas
St. Louis, Missouri			
Montana-Dakota Utilities Co.	12	12	Loop, Laurel to Billings, Montana
Minneapolis 2, Minnesota	3	2	Miles City, Montana, to USAF station
Mountain Fuel Supply Co.	6	6, 8	New line, near LaBarge, Wyoming
Rock Springs, Wyoming	0.4	2	New line, near Rock Springs, Wyoming
	6.3	16	Replacement, near Coalville, Utah
Natural Gas Pipeline Company of America	80	4-16	Wise County, Texas, gathering system
Chicago, Illinois	490	36	Loop lines between Fritch, Texas, and Joliet, Illinois
	21	26	Loop lines between Fritch, Texas, and Joliet, Illinois
New York State Natural Gas Corp.	13	20	Replacement, Potter County, Pennsylvania
Pittsburgh, Pennsylvania			
Niagara Mohawk Power Corp.	196	2-16	Central, eastern, and northern New York
Syracuse, New York			
North Carolina Natural Gas Corp.	725	2-16	Intrastate line in North Carolina
Fayetteville, North Carolina			
Northern Natural Gas Co.	7.1	24	Loop, Burt County, Nebraska
Omaha, Nebraska	17.2	30	Loop, Freeborn County to Steele County, Minnesota
	11.1	24	Loop, Clay County, Iowa
	5.3	24	Loop, Dodge County, Nebraska
	18.5	30	Loop, Gutherie County to Boone County, Iowa
	8	30	Loop, Ellsworth County to Lincoln County, Kansas
	9	30	Loop, Gage County, Nebraska
	167	20, 24	Dakota County to St. Louis County, Minnesota
	55.2	16, 20	New line, St. Louis County, Minnesota
	9	30	Loop, Stafford County to Barton County, Kansas
	12.5	30	Loop, Pottawattamie County, Iowa
	9.6	30	Loop, Edwards County, Kansas
	10.8	30	Loop, Cloud County, Kansas
	4.6	30	Loop, Gage County to Lancaster County, Nebraska
	4.5	30	Loop, Gage County, Nebraska
	8.1	30	Loop, Kiowa County, Kansas
	11.1	30	Loop, Beaver County, Oklahoma
	18	20	Dubuque County, Iowa, to Jo Daviess County, Illinois
	22	30	New line, Dakota County, Minnesota
Northern Plains Natural Gas Co. (subsidiary of Northern Natural Gas Company)	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Omaha, Nebraska			
Northern Utilities Co.	35	16	Fremont-Natrona counties, Wyoming
Casper, Wyoming	8	12	Near Casper
	6	8	Sand Draw field to Beaver Creek field
	12	6	Beaver Creek field to Riverton-Lander line
The Ohio Fuel Gas Co.	2.8	6⅝	Replacement, near Willard, Ohio
Columbus, Ohio	14.7	12	Replacement, near Crawford comp. station and Zanesville, Ohio
	2	16	Extension near Berea, Ohio
	3.5	20	Extension near Oberlin, Ohio
	9.7	8	Extension in Belmont County, Ohio
Oklahoma-Missouri Gas Transmission Co.	500	24	New system extending from Bradley, Oklahoma, district to Rolla and Webster Groves, Missouri
Tulsa, Oklahoma			
Oklahoma Natural Gas Co.	237	2-20	Various locations in Oklahoma
Tulsa, Oklahoma			
Pacific Gas and Electric	1390	36	High pressure gas line, Central Alberta, Canada, to San Francisco, California
San Francisco, California	7.4	8	High pressure gas line, Eureka to Arcata
	132	34	Topock to Milpitas (triple loop, two locations)
Pacific Lighting Gas Supply Co.	128	34	Needles to Newberry
San Francisco, California			
Pacific Northwest Pipeline Corp.	11	4	Main line to The Dalles, Oregon
Salt Lake City, Utah			
	52	30	Main line near Opal, Wyoming, to compressor station 23 near Big Piney, Wyo.
Pennsylvania Gas Co.	23	10	In Erie County
Warren, Pennsylvania	15	8	Warren County, Pennsylvania and Chautauqua County, New York Branch and distribution lines
	30	Var.	
Petroleos Mexicanos (Pamex)	130	22	Reynosa to Monterrey
Mexico City, Mexico	600	18, 24	Jose Colombo field to Tabasco to Vera Cruz to Mexico City
Piedmont Gas Co.	78	2-8	In Gaston, Lincoln, Catawba, Caldwell, and Burke counties, North Carolina
Hickory, North Carolina			
The Pittsburgh Group Companies of the Columbia Gas System	4.9	12	Replacement, Empire to Toronto, Ohio
Pittsburgh, Pennsylvania	16.9	20	York to Abbottstown, Pennsylvania

GAS LINES

Name of Company	Miles	Size	Location
Southern California Gas Co. Los Angeles, California	3	20	Loop, Kettleman-Lemoore system in Kings County, California
Southern Counties Gas Co. Los Angeles, California	20	24	Loop, Rainbow to Moreno
Southern California Gas Co. and Southern Counties Gas Co. Los Angeles, California	207	34	Ivanpah Lake to Placentia, California
Southern Natural Gas Co. Birmingham, Alabama	2.75	8	Dexter field to Sandy Hook line
	43	20	Loop, Elmore to Ellerslie
	79	16	Loop, Ocmulgee to Wrens
	5.7	8	Ship Shoal 32 to Ship Shoal 28
	53.09	16	Ship Shoal 28 to Duck Lake Rec.
	2.3	8	Coffee Bay to Lake Enfermer line
	8	8	Hub field to Dexter field
	39.5	14	Cranfield to Brookhaven
	39	16	Loop, Gwinville to Brookhaven
	42	20	Loop, White Castle to Franklinton
	4	12	Loop, White Castle to Franklinton
	17	20	Loop, Olga station to Toca station
Sui Gas Transmission Co. Karachi, Pakistan	130	16	Extension of Sui-Multan line to Lyalpur
Tennessee Gas Transmission Co. Houston, Texas	556	30	From Louisiana Delta to Portland, Tennessee
	448	—	Loops, Tennessee, Kentucky, West Virginia, Pennsylvania, New York
	21	16	Offshore Louisiana
	2	12	Offshore Louisiana
Tensas Gas Gathering Corp. Shreveport, Louisiana	37	2-8	Rodney field, Mississippi, to Olin Gas line connection across Mississippi River in Tensas Parish, Louisiana
Texas Eastern Transmission Corp. Shreveport, Louisiana	22	14	Rayne Field to Opelousas, Louisiana
Texas Gas Transmission Corp. Owensboro, Kentucky	12.5	16	Loop, Jefferson Davis and Acadia Parishes, Louisiana
	49.74	30	Loop near Alexandria, Louisiana
	23.57	30	Loop near Bastrop, Louisiana
	9.49	30	Loop near Greenville, Mississippi
	9.23	30	Loop near Clarksdale, Mississippi
	8.71	26	Loop near Hardinsburg, Kentucky
	10.02	26	Loop near West Point, Kentucky
	5	16	Loop in Henderson County, Kentucky
	7.55	10	Loop near Petersburg, Indiana
	2	6	Loop near Linton, Indiana
	1	6	Loop near Lawrenceville, Illinois
Transcontinental Gas Pipe Line Corp. Houston, Texas	496	20 & less	New purchase laterals, Louisiana
	363	30, 36	Loops, Texas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Pennsylvania, New Jersey
	193	23, 20	Storage facilities, Pennsylvania
Transwestern Pipeline Co. Houston, Texas	670	30	Mainline from Roswell, New Mexico, to Topock, Arizona
	635	24	Two laterals from West Texas and Texas-Oklahoma Panhandle gas fields converging at Roswell
Trunkline Gas Co. Houston, Texas	112.7	30	Loop from Marion to Neoga, Illinois
	117.4	30	Loop, Canadaville, Tennessee to Bardwell, Kentucky
	118.9	30	Loop, Kilbourne, Louisiana to Ballentine, Mississippi
	114.8	30	Loop, Pitkin to Riverton, Louisiana
	44.5	24	Loop, Moss Hill to Silsbee, Texas
	204	26	Bourbon, Illinois, to White Pigeon, Michigan
	111.4	Var.	Gathering lines, various locations
United Fuel Gas Co. Charleston, West Virginia	15.5	26	Loop, Clendenin, to Legg, West Virginia
United Gas Pipe Line Co. Shreveport, Louisiana	15	12	Carthage-Longview main line to North Henderson field
	117	30	Southeast Louisiana to Mobile area (Phase I)
	9	16	St. Rose-Harvey 16" main line to Paradise field
	9	16	Offshore-Kosciusko main line to Belle Isle field
	10	20	Extend south San Antonio 20" loop line to 20" Burnell-Converse main line
	13	20	Replacement, New Braunfels to Austin "B" main line

Lines Built or Underway

The following tables list details on crude, products, and gas lines built or under construction in the 12-month period ending September 1, 1958, as reported to *The Pipeline Engineer*.

CRUDE LINES

Name of Company	Miles	Size, in.	Location	Date Completed
Arapahoe Pipe Line Co. Chicago, Illinois	3.44	2	Gathering lines	UC
	1.43	3		
	21.1	4		
	3.7	6		
	18.1	8		
	1.96	10		

CRUDE LINES

Name of Company	Miles	Size, in.	Location	Date Completed
Argentine Government (YPF) Buenos Aires, Argentina	590	12	Camp Duran to San Lorenzo	UC
CATC Group (Continental, Atlantic, Tidewater, Cities Service) Ponca City, Oklahoma	22	12	Grand Isle to Block 47	3/10 58
	2	6	Offshore, Louisiana	
	1	8		
Cia. Shell de Venezuela Caracas, Venezuela	71	34	Boscan to Lake Maracaibo	UC
	70	30-34	Puerto Miranda to Bachaquero	UC
	31	30	Bachaquero to Cabimas	UC
Humble Pipe Line Company Houston, Texas	89.98	16	New line re-routed replacing 10" from Hawley to Comyn	5/14/58
	13.66	4	New line, Viboras field to Pita field	11/15/57
	13.8	8	Replacement, Rita-Sarita Jct. to Seeligson field	5/5/58
Interprovincial Pipe Line Co. Edmonton, Alberta, Canada	82.6	24	Loops in 4 sections of approximately 20 miles each, eastward from pump stations at Edmonton, Hardisty, Kerrobert, Loreburn	UC
Interstate Oil Pipe Line Co. Shreveport, Louisiana	4.7	6	Little Creek field to Mallalieu	UC
	4	8	Station, Mississippi	
Jayhawk Pipe Line Corp. Wichita, Kansas	242	10, 12	Meade County, Kansas, to Valley Center, Kansas	UC
Kuwait Oil Co. Ltd. London, England	61	30	Raudhatain to Ahmadi	UC
	28	34-40	Loop lines	UC
Magnolia Pipe Line Company Dallas, Texas	23	20	Enlarging present facilities from Corsicana to Mertens, Texas	9/57
	18	12¾	Enlarging present facilities from Walnut Springs to DeLeon, Texas	10/57
	85	16	Enlarging present facilities from DeLeon to Clyde, Texas	11/57
	5	12¾	Enlarging present facilities from Midland to Latan, Texas.	11/57
	120	16	Enlarging present facilities from Midland to Clyde	1/58
	40	16	Enlarging present facilities from Hull to Beaumont, Texas	4/58
Mid-Continent Pipe Line Company Tulsa, Oklahoma	12	4, 6	Maysville to Criner Oklahoma area	11/57
Nordwest Oelleitung MBH (Affiliate of Esso A. G.) Hamburg Germany	235	28	Wilhelmshaven to Cologne	UC
The Ohio Oil Company Findlay, Ohio	23	4	Maxie to Purvis, Mississippi	2/58
Pasotex Pipe Line Co. El Paso, Texas	195	20	Wink, Texas to El Paso	1958
Pembina Pipe Line Ltd. Calgary, Alberta, Canada	51.75	3, 6	Gathering lines connecting to existing lines in Pembina, Keystone, and Willesden Green oil fields	7/58
	32	16	Loop Colman to Edmonton, Alberta	6/58
Petroleo Brasileiro S. A. Rio de Janeiro, Brazil	40	12	Catu to Madre de Deus, Bahia	UC
Producers Pipelines Ltd. Regina, Saskatchewan, Canada	3.7	4, 6	Gathering line, Frobisher field	6/58
	16.6	4, 6	Gathering line, Steelman field	6/58
	5.3	4, 6	Gathering line, Alida-Edenvale-Manor	6/58
	.2	4	Gathering line, Ingoldsby	6/58
	5.5	4	Gathering line, Glen-Ewen, Oxbow	6/58
Pure Transportation Co. Chicago, Illinois	7.6	2, 3, 4, 5, 6	Gathering lines in Illinois, Oklahoma, and Louisiana	
Royal Dutch-Shell and others The Hague, Netherlands	700	30	Mediterranean Sea to North Sea, across France, Luxembourg, West Germany, Netherlands, and Belgium	UC
Service Pipe Line Co. Tulsa, Oklahoma	44	20	Casper to Welch, Wyoming	8/1/58
	34	20	Loop, Glendo to Fort Laramie, Wyoming	8/1/58
	30	12	Johnson County to Midwest, Wyoming	9/1/5
	12	12	Natrona County to Casper, Wyoming	9/1/58
The Shamrock Pipe Line Corp. Amarillo, Texas	45	4, 8	Replacement from McKee refinery, Moore County, to Hitchland field, Hansford County, Texas	10/57
Shell Pipe Line Corp. Houston, Texas	766.3	4, 16	Four Corners area to Los Angeles refining area (Line owned by Four Corners Pipe Line Company)	4/20/58
Sinclair Pipe Line Co. Independence, Kansas	149	20	Teague to Houston, Texas	7/15/58
	60	12	Wichita Falls to Jacksboro, Texas	UC
Skelly Oil Co. Tulsa, Oklahoma	50	8⅝	Pratt County to Kiowa County, Kansas	11/57
	50	12¾	Pratt County to Harvey County, Kansas	1/58
	12	6⅝	Kingman County to Harper County, Kansas	2/58
Texas-New Mexico Pipe Line Co. Houston, Texas	515	16	Aneth, San Juan County, Utah, to Jal, New Mexico	7/1/58
Trans Mountain Oil Pipe Line Company Vancouver, B. C., Canada	50.8	30	High pressure line from Edson pump station, Alberta, to Hinton Alberta	10/30/57
	50.8	30	High pressure line from Darfield, B. C., to Kamloops, B. C., Canada	10/30/57
	2.8	24	High pressure line from Mile 336 near Lempriere, B. C. to Mile 342	12/ 6/57
Trans-Prairie Pipelines Ltd. Edmonton, Alberta, Canada	31	4, 6	Weyburn field gathering lines	5/58
	5½	8	Weyburn field gathering lines	11/57
	¼	3	Daly field gathering lines	10/57
	37½	3, 4	North Virden Roselea gathering lines	5/58
	10	3, 4	Routledge gathering lines	5/58

PRODUCT LINES

Name of Company	Miles	Size, in.	Location	Date Completed
The Buckeye Pipe Line Co. New York, New York				
	55	10	New line, Syracuse to Utica, New York	9/58
Cherokee Pipe Line Co. Ponca City, Oklahoma	75	12	New line, Ponca City to Glenpool, Oklahoma	7/7/58
	398	10	Conversion, Glenpool, Oklahoma, to Wood River, Illinois	9/1/58
Emerald Pipe Line Corp. Amarillo, Texas	9	6	Emerald's pipeline to Okan pipeline near Liberal, Kansas	2/58
Everglades Pipe Line Co. Miami, Florida	35	10	Port Everglades to Miami	UC
	12	12	New line, Glenpool, to Tulsa, Oklahoma	7/1/58
Great Lakes Pipe Line Co. Kansas City, Missouri	91	8	Newport, Minnesota, to Chippewa Falls, Wisconsin	1958
	168	8	Minneapolis, Minnesota, to Duluth-Superior	1958
	11	8	Milepost 162 to Bettendorf, Iowa	1958
	70	8	Loop, Middlebury to Chicago, Illinois	1958
	34	12	Loop, Tulsa to Barnsdall, Oklahoma	1958
	14	8	Replacement, Coffeyville to Independence, Kansas	1958
Interstate Oil Pipe Line Co. Shreveport, Louisiana	16.1	4½	Baton Rouge refinery (Esso) to Dow Chemical plant, Louisiana	3/58
Laurel Pipe Line Co. Harrisburg, Pennsylvania	440	24	Philadelphia to Cleveland	UC
Leonard Crude Oil Co. Alma Michigan	43	6	Alma to Lansing, Michigan	6/58
The Ohio Oil Co. Findlay, Ohio	7	10	Clermont to Speedway, Indiana	1/58
Pasotex Pipe Line Co. El Paso, Texas	8	8	El Paso to Biggs Air Force Base, Texas	2/8/58
Phillips Petroleum Co. Bartlesville, Oklahoma	28	4	Adams Terminal to Texas City, Texas	12/27/57
	44	8	Borger to Amarillo, Texas	7/15/58
Plantation Pipe Line Co. Atlanta, Georgia	48	4	Bremen to LaGrange, Georgia	8/58
Southern Pacific Pipe Lines Inc. Los Angeles, California	35.7	4, 6	Niland to El Centro, California	1/58
	5.2	3, 4	Sacramento to Mather Air Force Base, California	4/58
	18	3, 4	Sacramento to McClellan Air Force Base, California	4/58
Texas Eastern Transmission Corp. Shreveport, Louisiana	233	14	Seymour, Indiana, to Chicago, Illinois	1/58
	12	14	Chicago extensions	7/58
Wabash Pipe Line Co. Findlay, Ohio	85	12	Robinson to Champaign, Illinois	5/58
	265	12	Wood River, Illinois, to Griffith, Indiana	8/58
West Emerald Pipe Line Corp. Amarillo, Texas	290	6	Amarillo, Texas, to Albuquerque, New Mexico	UC
Yacimientos Petroliferos Fiscales Bolivianos La Paz, Bolivia	127	16	Villa Montes, Bolivia to Villa Hayes, Paraguay	UC

GAS LINES

Name of Company	Miles	Size, in.	Location	Date Completed
Alberta Gas Trunk Line Co. Ltd. Calgary, Alberta, Canada	144.5	24	Pincher Creek to Princess Junction	9/1/58
	49	34	Cavendish to Princess Junction	9/1/58
	24	26	Cessford to Princess Junction	9/1/58
	1.2	18	Cessford lateral	9/1/58
	5.1	6⅝	Atlee-Buffalo lateral	9/1/58
	10.4	6⅝	Sibbald lateral	9/1/58
	1.7	8⅝	Steveville lateral	9/1/58
	1.3	8⅝	Princess lateral	9/1/58
	1.75	4½	Oyen lateral	9/1/58
American Louisiana Pipe Line Co. Detroit, Michigan	14	12, 16	Second Bayou and Holly Beach to Cameron, Louisiana	11/57
Arkansas Louisiana Gas Co. Shreveport, Louisiana	13.6	—	Haynesville field to Colquitt field, Louisiana	1/58
	11.4	—	Pine Bluff, Arkansas, to International Paper Co.	10/57
	41.9	—	Conway to Heber Springs, Arkansas	10/57
	18.5	—	Little Rock to England, Arkansas	12/57
	21.8	—	Ashdown to Foreman, Arkansas	UC
	16.1	—	Calhoun field to Union Parish, Louisiana	4/58
	5.9	—	Waskom, Texas, to Waskom-Greenwood area, Louisiana	5/58
	44.5	—	Hot Springs, Arkansas, to Lake Hamilton area	UC
Atlantic Seaboard Corp. Charleston, West Virginia	17.7	26	Loop between Seneca compressor station, Pendleton County, and Lost River compressor station, Hardy County	11/57
Canadian Western Natural Gas Co. Ltd. Calgary, Alberta, Canada	55	16	Carbon field to Calgary	UC
	45	Var.	Laterals and extensions	UC
Carnegie Natural Gas Co. Pittsburgh, Pennsylvania	9	55	Parallel lines from Clairton to Homestead, Pennsylvania	UC
	4	43		
Cities Service Gas Co. Oklahoma City, Oklahoma	6	4, 6, 8	Carson County, Texas	10/57
	5.5	10	Replacement, Carterville to Carthage, Missouri	11/57
	5.8	12	Replacement, Hutchinson, Kansas	11/57
	6.6	30	Replacement, Kansas City, Kansas	11/57
	80	30	Replacement, Independence to Welda, Kansas	1/58
	17	26	New line, Independence to Elk City, Kansas	4/58
Colorado Interstate Gas Co. Colorado Springs, Colorado	242	3-24	Various gathering lines	6/58

GAS LINES

Name of Company	Miles	Size, in.	Location	Date Completed
Columbia Gas of Kentucky Inc.	9.3	12	Replacement Lexington, Kentucky, area	11/57
Charleston, West Virginia	6.8	12	Replacement between Lexington and Midway, Kentucky	UC
Commonwealth Natural Gas Corp.	15.75	12	Loop, Waverly to Wakefield, Virginia	UC
Richmond, Virginia				
Consolidated Gas Utilities Corp.	30	8, 12	Altus to Sayre, Oklahoma	UC
Oklahoma City, Oklahoma				
Consumers Gas Co.	130	8	New line	9/58
Toronto, Ontario, Canada	65	8	Phelpston to Owen Sound	9/58
	28	6	Phelpston to Penetang	9/58
	11	4	Smiths Falls to Perth	9/58
	15	12	Barrie to Phelpston	9/58
	34	6	Lancaster to Hawkesbury	12/58
Consumers Power Co.	35	12	Overisel field to Kalamazoo, Michigan	1/58
Jackson, Michigan	45	24	Overisel field to Woodbury	UC
The East Ohio Gas Co.	110	24, 30	West Richfield, Ohio, to Summerfield	12/30/57
Cleveland, Ohio	12	30	West Richfield, Ohio, to Twinsburg	7/15/58
El Paso Natural Gas Co.	20.5	34	Loop, San Juan main line	6/58
El Paso, Texas	22.1	26	Loop, Gila station westward	7/58
	33.5	20	Sweetie-Peck to Goldsmith	UC
	67.2	30	Loop, Permian-San Juan main line	9/58
	10	30	Loop, Permian-San Juan main line	6/58
	97.9	18, 20	Panoma plant to Dumas plant	11/13/57
	176.8	20	Sonora plant to Plains plant	10/58
	18.1	12¾	Loop, Good plant to Vealmoor gasoline plant	1/31/58
	26	6⅝	San Manuel to Hayden	5/16/58
	59.1	20	Puckett plant to Upton County line	7/58
	21.2	10¾	Santa Rosa plant to Fort Stockton field	4/21/58
	18.6	8⅝	Loop, Santa Rosa plant	4/26/58
Gaz de France	550	16-24	Lacq field to Paris	UC
Paris, France	450	10, 12, 16	Laterals to Nantes and Lyons	UC
Gulf Interstate Gas Co.	24.78	2-12	New lines, various fields in South Louisiana	Var.
Houston, Texas	9.90	20	Loop, East Mud Lake Junction to Thornwell Junction	12/30/57
	216.30	30	Loop, approximately 35 miles north of each station	UC
	133.40	30	Loop, approximately 35 miles north of each station	UC
Houston Pipe Line Co.	18.6	6, 8	Mission Valley to Fannin	3/23/58
Houston, Texas	17	4, 8	Speaks to Cordele	5/4/58
	11	18	Refugio to Vidauri	4/28/58
	15.4	16	Point Comfort to Edna	5/31/58
Humble Pipe Line Co.	78	24-30	Clear Lake to Port Arthur	UC
Houston ,Texas				
Kansas-Nebraska Natural Gas Co.	2	6	Padroni gasoline plant to Sterling gathering system	5/28/58
Hastings, Nebraska	1.5	12	Gathering lines, Logan County, Colorado	5/2/58
	1	4	Gathering line, Finney County, Kansas	5/15/58
	3	6	Gathering line, Pawnee County, Kansas	6/17/58
	5	4, 6	Gathering line, Texas County, Oklahoma	7/15/58
	4	4	Gathering line, Finney County, Kansas	7/15/58
	6	4, 6	Surveyors Creek field to Akron, Colorado	9/58
	22.5	6	Akron to Atwood, Colorado	8/15/58
Kentucky Gas Transmission Corp.	20.5	26	Loop, Foster measuring station, Bracken County, Kentucky, to Cold Spring measuring station, Campbell County, Kentucky	UC
Charleston, West Virginia				
Lone Star Gas Co.	17.93	6⅝	Loop, Hamilton County, Texas	UC
Dallas, Texas	24.88	12¾	Wichita Falls, Texas, to New York City field	12/57
	20.65	20	Loop, Waco to Eddy, Texas	12/57
		16	Loop, Freestone County, Texas	3/58
	12.60	8⅝	New line, Red River County, Texas	12/57
Many Island Pipelines Ltd.	22	10, 16	From Many Islands to Hatton	6/17/58
Regina, Saskatchewan, Canada	29.6	3-8	New line, Many Islands area	UC
Michigan Consolidated Gas Co.	67	10, 12	Sears and Traverse City	UC
Detroit, Michigan	60	10, 12	Muskegon and Ludington	UC
Michigan Wisconsin Pipe Line Co.	46	24	Loop, Illinois and Wisconsin	12/57
Detroit, Michigan	4	12	New Berlin, Wisconsin, lateral	11/57
	2	6	Niles, Michigan, lateral	12/57
	10	6	Holland, Michigan, lateral	11/57
	2	6	St. Joseph, Michigan, lateral	12/57
	56	20	New Laverne field, Oklahoma, extension	UC
Mississippi River Fuel Gas Corp.	54	26	Loop, Perryville, Louisiana, to St. Louis, Missouri	11/1/57
St. Louis, Missouri				
Montana-Dakota Utilities Co.	6	12	Replacement, Manden to Bismarck, North Dakota	10/25/57
Minneapolis, Minnesota	3	6	Warren, Montana, to Elk Basin, Wyoming	10/25/57
	12	3	Belle Fourche, South Dakota, to Colony, Wyoming	12/10/57
Mountain Fuel Supply Co.	2.1	2, 3, 4	Gathering lines in Hiawatha and Sugar Loaf fields, Moffat County, Colorado	8/58
Salt Lake City, Utah				
	6.5	18	Replacement near Coalville, Utah	10/58
	0.6	16	Replacement near Rock Springs, Wyoming	6/58
	1.2	8	Replacement near Rock Springs, Wyoming	7/58
Natural Gas Pipeline Company of America	125.49	Var.	Wise County to Fritch, Texas	1/11/58
Chicago, Illinois	88.06	20	Wise County to Fritch, Texas	10/25/57
	85.18	26	Wise County to Fritch, Texas	11/27/57
	85.56	26	Wise County to Fritch, Texas	1/24/58

GAS LINES

Name of Company	Miles	Size, in.	Location	Date Completed
	87.53	26	Wise County to Fritch, Texas	11/26/57
	25.06	4-12	Gathering system, Wise County, Texas	7/2/58
	31.94	4-6, 12	Gathering system, Wise County, Texas	6/12/58
	38.46	4-12	Gathering system, Wise County, Texas	UC
	513	26, 36	Loop along system from Texas to Illinois	UC
	12	4½, 6⅝, 12	Gathering system, Moore and Carson counties, Texas	10/16/57
Niederoesterreich Gas vertriebs A. G. Vienna, Austria	150	6, 10, 12	Bockfleiss to Danube Basin	UC
Northern Natural Gas Co. Omaha, Nebraska	70.9	30	Loop, Ochiltree County, Texas	1/17/58
	9.3	30	Loop, Ochiltree County, Texas, to Beaver County, Oklahoma	2/7/58
	13.1	30	Loop, Clark County, Kansas	2/14/58
	18.2	30	Loop, Kiowa County, Kansas	2/22/58
	10	30	Loop, Stafford County, Kansas	12/5/57
	7.1	30	Loop, Ottawa County to Cloud County, Kansas	11/15/57
	4	30	Loop, Jefferson County to Gage County, Nebraska	11/15/57
	4.8	30	Loop, Washington County, Kansas	11/15/57
	8	24	Loop, Burt County, Nebraska	5/28/58
	8.8	30	Loop, Mills County, Iowa, to Pottawattamie, Iowa	11/30/57
Northern Ontario Natural Gas Co. Ltd. Port Arthur, Ontario, Canada	90	10	North Bay to Sudbury	UC
Northern Ontario Pipe Line Crown Corp. Calgary, Alberta, Canada	57.7	30	Manitoba-Ontario boundary to Willard Lake	12/57
	94.1	30	Willard Lake to west of Raleigh	12/57
	80.4	30	West of Raleigh to west of Upsala	12/57
	78.5	30	West of Upsala to Port Arthur	11/57
	63.7	30	Port Arthur to Nipigon	9/58
	48	30	Nipigon to Beardmore	9/58
	70.8	30	Beardmore to Longlac	9/58
	90.3	30	Longlac to Ryland	9/58
	92.6	30	Ryland to Kapuskasing	9/58
Northwestern Utilities Ltd. Edmonton, Alberta, Canada	26	16	Pembina field to Edmonton	UC
	94	Var.	Gathering lines, Pembina field	UC
The Ohio Fuel Gas Co. Columbus, Ohio	12.8	4-20	Storage lines, near McArthur, Ohio	10/15/57
	15.6	3-6	Storage lines, Shreve to Loudonville, Ohio	10/20/57
	36.2	24	Partial loop, Pavonia comp. station junction line D-366	11/12/57
	22.3	18-20	From Line D-100 Gibsonburg, Ohio, to east side Toledo, Ohio	11/22/57
	7	16	Loop, Howell Station, Green County, to Z & Z-62-Springfield, Ohio	10/14/57
	4.6	12	Holmes compressor station to L-400 near Big Prairie, Ohio	1/14/58
	4.6	20	Partial loop, Centerville Station, Montgomery County, to West Carrollton, Ohio	11/26/57
	7.6	12	Extension, near Mt. Sterling toward Washington C. H., Ohio	11/22/57
	4.9	20	Extension, near Wellington Station to Pittsfield, Ohio	11/18/57
	10	20	Partial loop, near Mt. Gilead, Ohio, toward Green Camp, Ohio	12/17/57
	4.1	8	Partial replacement, near Wills Station, Guernsey County, toward Cambridge, Ohio	11/22/57
	1.1	20	Partial replacement, near Mt. Sterling compressor station to Madison County, Ohio	7/2/58
	1	6	Partial replacement, west of North Hampton, Ohio	7/2/58
	2.6	4	Gathering lines in Franklin Township, Wayne County	5/19/58
	1	18	Replacement, near Athens, Ohio	UC
	15	12	Replacement, Big Prairie to Malvern, Ohio	UC
	11.6	4-20	New line, York and Lafayette Townships, Medina County	UC
	3.8	18	Replacement, Green and Clark counties	UC
	3.8	8	Extension near West Liberty, Ohio	UC
Oklahoma Natural Gas Co. Tulsa, Oklahoma	246.4	2-20	Various locations in Oklahoma	1957
Pacific Gas and Electric Co. San Francisco, California	138	34	High pressure loop line from Topok, Arizona, to Milpitas, California	5/23/58
	163	12	High pressure line from Corning to Eureka	UC
Pacific Lighting Gas Supply Co. San Francisco, California	82.5	34	North Coles Levee to Newhall	UC
	2.5	16	New line, Whittier area	10/57
	1.5	4	New line, Ojai area	6/58
Pacific Northwest Pipeline Corp. Salt Lake City, Utah	28.21	6	Spokane, Washington, to Coeur D'Alene, Idaho	10/22/57
	8.09	4	Pullman, Washington, to Moscow, Idaho	10/13/57
	35.84	6	Coeur D'Alene, Idaho, to Kellogg, Idaho	11/9/57
	35.14	4, 6	From main line near Monroe, Washington, to Grotto, Washington	11/19/57
	3.75	3	From a point on Uravan lateral to Slick Rock, Colorado	10/25/57
	2.48	4	Gathering line, Piceance Creek field	7/1/58
	32.93	3, 4, 6	Gathering line, Big Piney field, Wyoming	7/1/58
	2.28	4	Gathering line, Bar-X field	7/1/58
	140.81	2, 3, 4, 6, 8, 12, 16	Gathering lines, San Juan Basin	7/1/58
Pacific Petroleums Inc. Calgary, Alberta, Canada	49	12, 18, 20	Along Alaska Highway	UC
	20	12	Kobes Creek lateral	UC
	7	8	West Blueberry lateral	UC
	7	10	Gundy Creek lateral	UC
Panhandle Eastern Pipe Line Co. Kansas City, Missouri	9.71	4, 6	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	10/57
	8.89	4, 6	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	11/57
	6.75	4, 6, 8	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	12/57
	0.56	4	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	1/58
	1.70	4	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	2/58
	6.95	6	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	3/58
	7.37	6	Gathering lines from Hugoton field to Kansas, Oklahoma, and Texas	4/58

GAS LINES

Name of Company	Miles	Size	Location	
The Peoples Natural Gas Co.	39.6	2-20	Field and transmission lines	1957
Pittsburgh, Pennsylvania	6.8	2-6	Distribution lines	1957
	4	6, 8, 10	Renew distribution lines between Greenwood and Bellwood, Pennsylvania	1958
	4	8, 12	Renew distribution lines Richland Township, Allegheny County, Pennsylvania	1958
	2.27	6, 10	Renew lines near Indiana, Pennsylvania	1958
	4	6, 8, 10	Renew lines between Bellwood and Tyrone, Pennsylvania	1958
	2.5	12	Replace storage line between Wall Station and Webster storage pool	1958
	17	20	Replace transmission line between Derry and Morrellville, Pennsylvania	1958
	4	12	Replace transmission line in the vicinity of Mars, Pennsylvania	1958
	4	12	Replace transmission line between Girty Station and Derry, Pennsylvania	1958
	5.5	12	Renew line between Leechburg and New Kensington, Pennsylvania	1958
	16	24	New line between McKeesport and Gibson Station	1958
Permian Basin Pipeline Co.	27.8	10	From Pecos and Schleicher counties, to Midland County, Texas	1/24/58
Omaha, Nebraska	84.7	16	Pecos and Schleicher counties, to Midland County, Texas	12/19/57
Pioneer Natural Gas Co.	22.06	8, 10	Enlargement, Friona to Lariat	3/1/58
Amarillo, Texas	30.15	2, 3, 4, 6	New lines, Panhandle, South Plains and Permian Basin of West Texas, to various locations	1957-58
	62	10	Pampa to Canyon, Texas	
	20	Var.	Gathering lines	
The Pittsburgh Group Companies of the Columbia Gas System	7.5	8	Buffington Township, Indiana County, Pennsylvania, to 16" line Cherryhill Township, Indiana County, Pennsylvania	5/16/58
Pittsburgh, Pennsylvania	8.8	10	West Bradford Township to West Vincent Township, Pennsylvania	11/26/57
	7.6	12	Buffalo District, Brooke County, West Virginia, to Cross Creek District, Brooke County, West Virginia	4/3/58
	5.6	26	Replacement, Hickory, Pennsylvania, to Robinson Township, Washington County, Pennsylvania	7/15/58
	15.6	20	Waynesburg, Pennsylvania, to Green Township, Greene County, Pennsylvania	8/15/58
	7	4	Upshur and Barbour counties, West Virginia and Garrett County, Maryland, to company and purchase wells	2/2/58
	19.5	16	Loop, Dundee to Quackenbush Hill, New York	11/23/57
	7.94	4, 6, 8, 12, 16	New line near Dundee, New York	12/23/57
Rio Grande Valley Gas Co	4	4	Port Brownsville to Shrimp Harbor, Brownsville, Texas	6/58
Brownsville, Texas				
Saskatchewan Power Corp.	38.6	12	Moose Jaw to Regina	5/1/58
Regina, Saskatchewan, Canada	124	10	Regina to Steelman	UC
	89.5	14	Hatton to Success	UC
	27	3-8	Hatton area	UC
	17	6⅝	Steelman to Estevan	6/27/58
	4	6⅝	Estevan to Estevan General Station	UC
	10	4½	Maple Creek lateral	UC
Southern California Gas Co. and Southern Counties Gas Co.	18	30	Quigley Station to Burbank Boulevard and Yarmouth Avenue, Los Angeles, California	UC
Los Angeles, California				
Southern Natural Gas Co.	7.2	8	Manila Village to Lake Enfermer line	10/17/57
Birmingham, Alabama	9	8	Bastian Bay to Fort Jackson tie-in	12/26/57
	1	8	Fort Jackson to Bastian Bay line	11/30/57
	0.9	12	Bastian Bay line	10/25/57
	3.5	12	Block 46 to Block 47	8/1/58
	1.3	12	Block 47 to Block 48	12/1/57
	4.8	12	Block 48 to Olga receiving station	11/17/57
	4	12	Fort Jackson tie-in to Olga receiving station	12/26/57
	2.5	6⅝	Cox Bay to 20" East Leg	3/15/58
	6.7	8	Point A LaHache to 20" East Leg	4/28/58
	2.2	4½	Little Lake to Lake Enfermer line	1/26/58
	1.7	20	Loop, Toca station to Pontchartrain	10/31/57
	10.72	4½	Point Confort to Eloi Bay	5/27/58
	8.78	6⅝	Eloi Bay to Lake Fortuna	5/27/58
	5.93	8	Lake Fortuna to Black Bay	5/27/58
	2.84	12	Black Bay Junction to Lake Campo	5/27/58
	6	12	Lake Campo to 20" East Leg	5/27/58
	8.20	10	Black Bay to Black Bay Junction	6/15/58
	1	4½	North Black Bay to Black Bay line	9/1/58
	46	20	White Castle to South Section 28	UC
	6.5	10	Bayou Boullion to South Section 28 line	UC
	11.5	8	East Happytown to Bayou Boullion	UC
	7.5	10	Loisel field to South Section 28 line	UC
	11.5	8	Loisel field to South Section 28 line	UC
	19.2	12, 20	Lake Washington to 20" East Leg	UC
	21.5	12	West Delta Block 30 to Lake Washington	UC
	5.6	4½	Bayou Villars to Barataria	UC
	11.6	6⅝	Marrero field to Gloria station	UC
	6.4	6⅝	South Lake Long to Montegut	UC
	0.5	4½	Tigers Ridge to Barataria line	UC
	34.7	16	Montegut to Gloria station	UC
	16.2	12, 16	Loop, Gloria station to Toca station	UC
	69	24	Loop, Franklinton to Toca	UC
	67.4	26	Loop, Franklinton to Gwinville	UC
	8.5	16	New line, 20" west leg to Bayou Long	UC

GAS LINES

Name of Company	Miles	Size	Location	
	7.3	16	Little Bayou Pigeon to Bayou Long	UC
	3.8	6⅝	Mystic Bayou to 20" west leg	UC
	1.92	6⅝	E. Bayou Pigeon to Bayou Long	UC
	4.03	20	Loop, Gwinville to Rankin station	UC
	3.16	20	Loop, Rankin station to Pickens	UC
	12.5	10	Tantine field to Bastion Bay line	UC
	67	24	Loop, Gwinville to Enterprise	UC
	71	24	Loop, Enterprise to Gallion	UC
	82	24	Loop, Gallion to Elmore	UC
	46	24	Loop, Elmore to Ellerslie	UC
	68	20	Loop, Ellerslie to Ocmulgee	UC
	7.7	6⅝	Loop, north main line to Vicksburg	UC
	4.72	12	Loop, north main line to Columbus	UC
	9	8	Loop, Alabaster to Calera	UC
	22	14	Loop, north main line to Cedartown	UC
	8	8	Loop, Opelika Junction to Opelika	UC
	61	14	Loop, Ocmulgee station to South Atlanta	UC
	8	6⅝	New line, Bayou Felice to Tantine field	UC
	1	4½	New line, Triumph to Bastian Bay line	UC
	4.5	6⅝	Loop, north main line to Vicksburg	UC
	1.7	4½	Bayou Postillion to Bayou Long	UC
Southern Union Gas Co. Dallas, Texas	2.25	4, 6	From El Paso Natural Gas Company line on Highway 53, near Grants, New Mexico, to Ambrosia Lake area, New Mexico	3/1/58
	12.7	20	Loop from north of Albuquerque to south of Albuquerque, N. M.	10/2/57
	6.7	6	Flora Vista to Farmington, New Mexico	10/22/57
	4.5	6	Replacement, Hobbs to Hobbs Airfield, New Mexico	10/30/57
	13.5	12	Loop, Lybrook to terminus of 18" loop line Albuquerque, New Mexico	UC
	27.9	2, 4, 6	Almagordo to Tularosa, New Mexico	UC
Soviet Union Moscow, Russia	807	32	Stavropol to Moscow	UC
	600	—	Dzarkak-Bukhara-Tashkent	UC
	500	—	Serpukhov to Leningrad	UC
	186	—	Shkapovo fields, Bashkiria, to Magnitogorsk	UC
Texas Eastern Penn-Jersey Corp. Shreveport, Louisiana	12	30	Pennsylvania loops	UC
Texas Eastern Transmission Corp. Shreveport, Louisiana	413	30	McAllen to Vidor, Texas	10/57
	530	30	Loop, Kosciusko, Mississippi to Uniontown, Pennsylvania	12/57
	47	24	Provident City to Blessing, Texas	10/57
	97	156	Loop, Kosciusko, Mississippi, to Connelsville, Pennsylvania	12/57
Texas Illinois Natural Gas Pipeline Company Chicago, Illinois	47.63	36	Volo loop, Illinois	12/17/57
Trans-Canada Pipe Lines Ltd. Calgary, Alberta, Canada	85.2	30	Ile des Chenes to Manitoba-Ontario boundary	10/57
	81.9	30	Kapuskasing to Iroquois Falls	9/58
	83	30	Iroquois Falls to Englehart	9/58
	57.3	30	Englehart to Timagami	9/58
	47.4	30	Timagami to Tilden Lake	8/58
	62.1	30	Tilden Lake to South River	9/58
	62.8	30	South River to Bracebridge	9/58
	91.6	30	Bracebridge to Kleinburg	9/58
	85.3	20	Sheridan to Bowmanville	10/58
	99	20	Bowmanville to Kingston	12/57
	155	20	Kingston to "L" of two mountains	11/57
	36.5	12	Lateral, Williamsburg to Ottawa	11/57
Transcontinental Gas Pipe Line Corp. Houston, Texas	113	30, 36	Loops, Texas, Louisiana, Alabama, Georgia, South Carolina, North Carolina, and Virginia	UC
	13	24	New purchase lateral, Louisiana	UC
	238	10, 14, 16, 24	New purchase lateral, Texas	UC
Union Gas Company of Canada Ltd. Chatham, Ontario, Canada	142	26	Dawn Storage field to Lisgar	12/15/57
	10.5	12	From 26" line to Waterloo	12/57
	13.2	10	From 26" line to Guelph	10/57
	7.6	6	From 26" line to St. Marys	5/58
	45	8	Stratford to Goderich	9/58
	10.5	8	Windsor to Amherstburg	8/58
	10	12	Replacement, from 26" line to Brantford	9/58
United Fuel Gas Co. Charleston, West Virginia	7.7	12	Replacement, Sandyville to Ravenswood, West Virginia	10/57
	29	10	Milton to Apple Grove, West Virginia	UC
	4.7	4–10	Part replacement, Charleston, West Virginia, area	UC
United Gas Pipe Line Co. Shreveport, Louisiana	16	10	Loop, Goodrich-Houston main line to Liberty field	12/14/57
	5	20	Refugio-Houston main line to Houston L. & P. Company, Smithers Lake power plant	12/16/57
	17	12	Lirette-Mobile main line to Bayou Casotte industrial area	4/21/58
	22	20	Burnell-Converse 20" main line to Fashing field	7/1/58
	30	8, 16	From Kent Bayou 20" main line to connect Bayou Penchant field, Deer Island field, Palmetto Bayou field, Halter Island field, and Four League Bay areas	7/15/58
Virginia Gas Distribution Corp. Charleston, West Virginia	4.7	10	Replacement, Staunton, Virginia, area	10/57
	3	4, 6	Extension, Waynesboro, Virginia, area	11/57
Westcoast Transmission Co. Vancouver, B. C., Canada	8.5	8, 10, 12, 18, 20	New line from various gas field along the Alaska Highway between milepost 73 and milepost 130 to MP 73 Alaska Highway	9/58
	1.25	20	Loop, from Alaska Highway milepost 38 to Taylor, B. C.	8/58
	80	Var.	Gathering lines, Peace River area	UC

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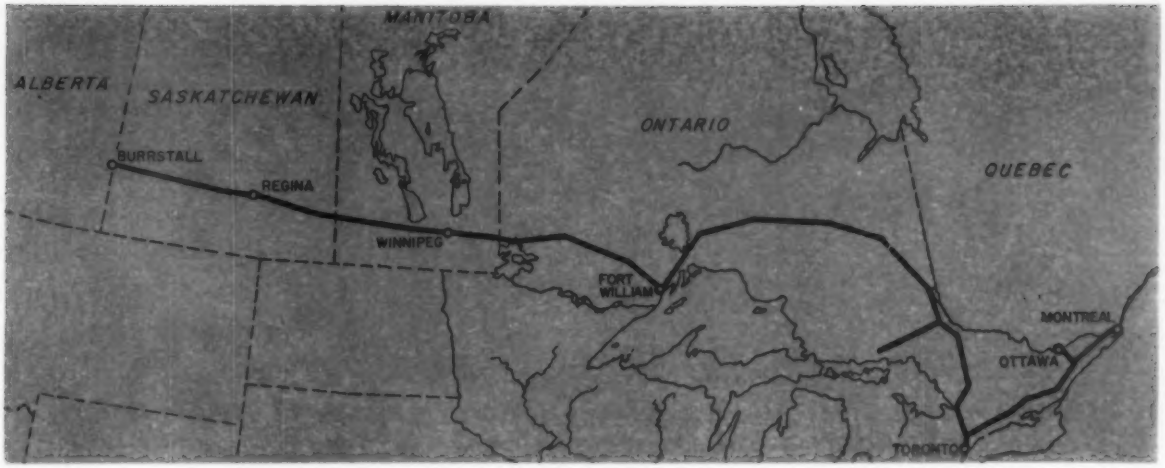


Trans-Canada Pipe Lines' project is by far the largest single gas transmission job of 1958.

CANADIAN CONSTRUCTION OFF 16%

Nevertheless, it represents the Dominion's second largest year with 4200 miles of pipeline to be completed in 1958

Leslie Orr Rowland

ALTHOUGH not quite matching the all-time record year of 1957 in total pipeline construction mileage in Canada, 1958 will come close to last year's volume to make a spectacular second largest season, providing a substantial amount of work for at least 50 spreads.

The combined mileage of natural gas and oil pipelines will amount to about 4200 miles, off only 16 percent from the 1957 peak of 5000 miles.

Natural gas lines have stolen the show from oil for the second year in a row, with an estimated 3600 miles compared to about 4300 miles in 1957, while construction of oil lines will be 600 miles, nearly up to last year's 700 miles. Gathering systems and natural gas city and town distribution lines are included in both totals.

The major shift of emphasis to natural gas that took place in 1957, sparked by the second and completing year of construction of the Westcoast Transmission line to the west coast of British Columbia, is being sustained through 1958 by the assurance of completion of the Trans-Canada gas line to eastern Canada.

The latter project has brought in its wake a tremendous outbreak of local distribution system construction all along the 1100 miles of its route from the Manitoba-Ontario border to Toronto, and along the 300-mile section from Toronto to Montreal, which was laid last fall.

Construction of most of these systems has been proceeding concurrently with the main line, activity including numerous communities on the route of the Crown Corporation line between the Manitoba-Ontario border and Kapuskasing, Ontario, which is to be turned over to Trans-Canada on a long-term lease upon completion of the second section in the fall. Work which started late last season on the section of this line between Manitoba and the Lakehead cities of Fort William and Port Arthur made little progress through the winter, but has been largely completed this year in time to assure a full winter's delivery season and an even earlier start of industrial and commercial deliveries.

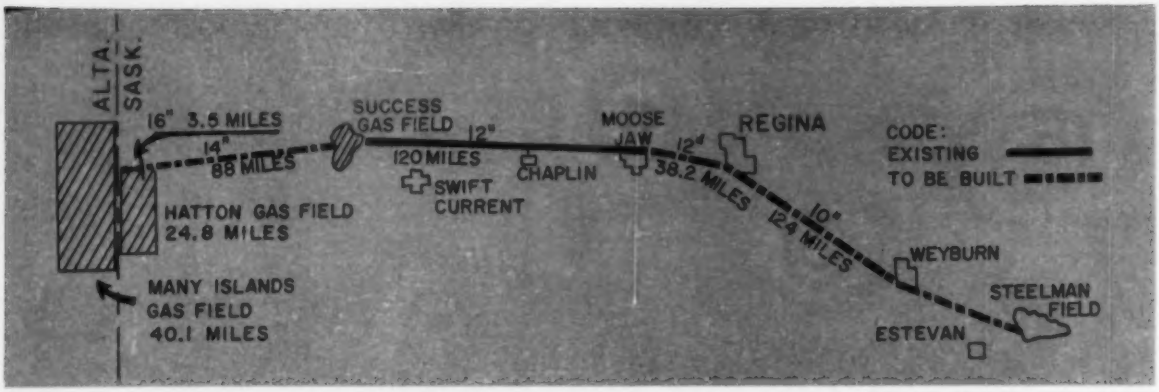
Trans-Canada the Big Project

Trans-Canada Pipe Lines, Ltd.'s project is by far the largest single job for the 1958 season, as it was in 1957, and the collateral jobs that depend on it represent a gigantic mileage to be crammed into one construction season. The impact of this situation has been a major shift of geographical emphasis from western to eastern Canada, with more than half the total mileage of pipeline construction for 1958 being concentrated in the province of Ontario and practically nothing in British Columbia where more than 1200 miles were laid last year.

Construction in the prairie provinces also is far below last year's level because of completion of the Trans-Canada trunk line last year, but volume in this region was sustained in part by the largest season on record for Saskatchewan Power Corporation, which is nearly doubling the mileage of natural gas main transmission, lateral, and local distribution lines that it had in operation at the end of last year.

The Trans-Canada main line construction this year amounts to 486 miles, extending from Kapuskasing, in northern Ontario, to the village of Maple, a few miles north of Toronto, where the Toronto lateral takes off and the main line continues on to Montreal. It is divided into seven sections, with mileages varying according to topography and terrain from the shortest

Editor, *Oil in Canada*.



Saskatchewan Power Corporation will complete 500 miles of pipeline this year, expanding its system by 80 percent.

of 47 miles through almost solid rock to the longest of 92 miles in the gently rolling farmland of south central Ontario.

Trans-Canada starts at the south end in highly cultivated farm land, which contains numerous small ponds and creeks, but the soil is well compacted and easy to ditch for about 150 miles. Then it follows an abrupt transition to the homogeneous and very tough granite rock of the PreCambrian Shield, which has few fracture plains and requires drilling and shooting for the major part of the next 150 miles. Much of this region, however, is wilderness recreation area, almost undeveloped and presenting virtually no problems of right-of-way obstructions. The remaining 186 miles is mostly in gently rolling farm land, with a gradual transition to the clay belt at the north end and a few large swamps and muskegs. A great many water crossings are involved, especially in the solid rock sections, where on one spread there are 19 major water crossings in 57 miles, mostly in solid rock.

The Crown section, being laid for Northern Ontario Pipe Line Crown Corporation, a joint venture of the dominion government and the Ontario provincial government, comprises 367 miles from the Lakehead city of Port Arthur to the pulp mill and lumber town of Kapuskasing, around the north shore of Lake Superior, and out into the muskeg terrain of far northern Ontario, ending in the early portion of the clay belt. The first 100 miles is solid granite rock in the Pre-Cambrian Shield. The next 50 miles represents a transition through rock into muskeg, while the next 150 miles is largely muskeg, ranging from practically bottomless to a thin overlay on the clay. The final 67 miles is clay belt, involving few terrain problems.

One of the major difficulties encountered by contractors on this line is the lack of access to the right-of-way along the muskeg portions, with pipe stringing having to be done at distances of up to 50 miles. The almost complete absence of accommodation in the central wilderness section also involved setting up a mobile field camp on one spread. Otherwise operating conditions on both Crown and privately owned sections are normal.

On most of both lines right-of-way access is very easy, as the right-of-way parallels closely the main Trans-Canada highway, which is hard-surfaced all the way from Port Arthur to Toronto.

Gas Deliveries November 1

The projected completion date for both Crown and private sections is October 1, with first deliveries of gas scheduled for November 1.

Seven spreads are working on the Trans-Canada line and five on the Crown line. Eight major river crossings, which were let under separate contracts, are also scheduled for completion concurrently with the main transmission line. The combined mileage of both sections is 853 miles of 30-in. line, making up the largest job in Canadian pipelining history for a single construction season with big-inch pipe, and exceeding by about 100 miles the total big-inch mileage on Trans-Canada and Crown Corporation jobs in 1957.

The largest individual lateral taking off from the Trans-Canada line is the Sudbury lateral, involving 90 miles of 10-in. pipe running from the North Bay compressor station, 230 miles north of Toronto, to the mining town of Sudbury in the western peninsula of Ontario where the International Nickel Company smelter is situated.

Other laterals and city distribution systems along the Trans-Canada and Crown routes through Ontario are being laid for Northern Ontario Natural Gas Company, Ltd., a private corporation which has obtained franchises for every community on the 1100-mile route. Its 1958 construction program, which includes the Sudbury lateral, calls for another 410 miles of laterals, local distribution mains and services. Its enfranchised territory includes such important towns as North Bay, Kirkland Lake, Haileybury, Orillia, Bracebridge, Geraldton, Hearst, and Kapuskasing. Altogether the Northern Ontario company has valid franchises for 33 Ontario communities, in most of which it intends to complete primary installations this year.

In the eastern end of the Trans-Canada territory, about 300 miles of lines are being laid by other utility companies, which hold franchises for cities and towns between Toronto and Montreal, in Canada's most highly developed and rapidly growing industrial and population region. The principal operator in this area is Lakeland Natural Gas Company, Ltd., with 21 valid franchises, and major cities included in the 1958 program are Kingston, Gananoque, Port Hope, Cobourg, Brockville, and Trenton.

Union Gas Company of Canada, Ltd., which will be a large customer of Trans-Canada as soon as the main line is completed into its southern Ontario territory, is engaged in a program of about 150 miles of line, which is extending service to several cities and towns in the southern sector and enlarging existing systems that in some cases, have had gas service for more than 50 years. In the new category are Goderich and Amherstburg, while in the group of existing services are Waterloo, Guelph, London, and Hamilton.

Consumers' Gas Company, which will be another large customer of Trans-Canada, is laying about 500 miles of laterals and distribution lines, of which a large share will be in the city of Toronto where a continuous expansion project has been in progress for several years.

Approximately 150 miles will be laid by Quebec Natural Gas Corpora-

tion, a new entity in the natural gas distribution system, serving the entire province of Quebec as successor to the publicly owned company that previously operated the manufactured gas system in the city of Montreal.

Thus a total of about 1600 miles of natural gas pipelines will be laid in eastern Canada this year, of which all but a small proportion will be the direct result of the Trans-Canada completion, the others being dependent on continued imports of gas from the United States, which are being used particularly by Union Gas, under long-term contracts.

Franchise Conflicts in Manitoba

Natural gas pipeline construction in Manitoba this year is non-existent, because of serious franchise conflicts and the necessity of making a judicial determination on the contest between Winnipeg and Central Gas Company, in the greater Winnipeg area, and two competitors who contend that the Winnipeg company is not entitled to an exclusive franchise in the whole Winnipeg metropolitan area. Pending the report of a special inquiry commission appointed by the provincial government early in the summer, it has been impossible for any company to lay pipe in the area, and at mid-summer it appeared unlikely that any decision would be reached in time to permit further work this year by any franchise holder. Outside the city, one tentative plan for service to several communities in southern Manitoba was still in suspension at mid-summer because of dubious economic foundation for its project and the consequent difficulty of obtaining financing.

Saskatchewan Booming

Saskatchewan, however, is far more than making up for the lack of activity in Manitoba. The largest natural gas pipeline construction program in the seven-year history of the natural gas phase of Saskatchewan Power Corporation is bringing to completion a total of nearly 500 miles of main transmission line extensions, laterals, and local distribution systems.

The size of the 1958 program is going to add more than 80 percent to the existing 674 miles that were contained in the almost province-wide system at the end of 1957 and which took six years to build up. The major element contributing to this year's gigantic expansion was the procuring of a permit from the Alberta Conservation Board for the use of Alberta gas in the Many Island field on the east side of the province, adjoining the big Hatton field in western Saskatchewan. The award of this permit made it possible for the two fields to be opened up for joint commercial operation and provided assurance of enough gas supply to support the large extensions contained in the current program.

The main transmission line extensions include 124 miles of 10-in. line from Regina to the Steelman oil field, 32.2 miles of 12-in. from Regina to Moose Jaw, 88 miles of 14-in. and 3.5 miles of 16-in. for the link from the Hatton gas field to the Success gas field. This total of 254 miles will essentially complete the main line in a continuous arc right across the entire southern half of the province, providing a base for future take-offs of laterals to provide gas service for every community of economic size.

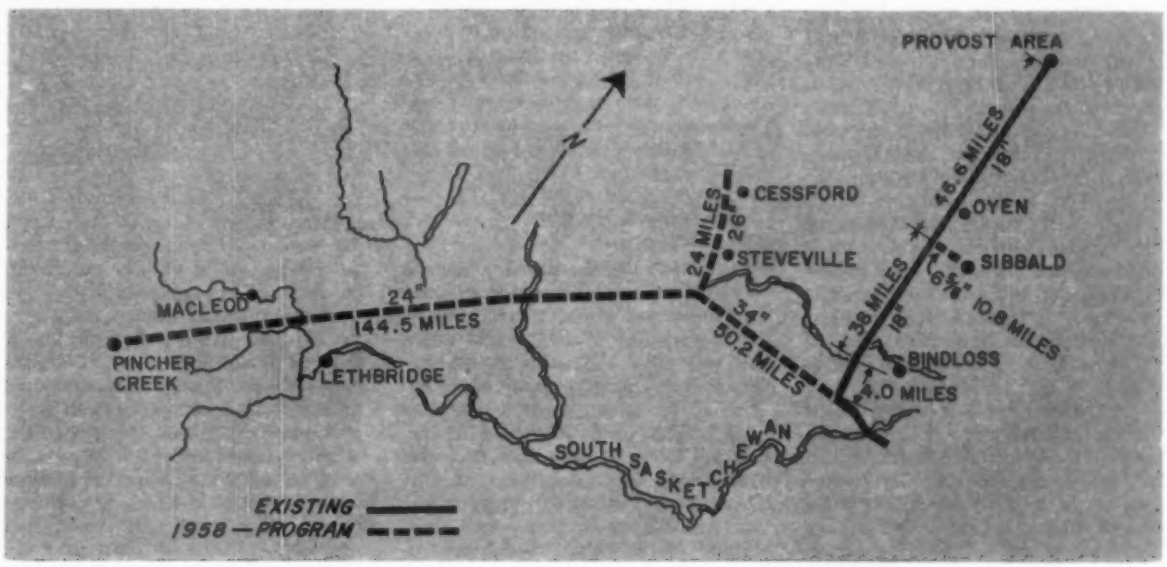
The Hatton field gathering system will involve construction of 25 miles of various small-diameter lines, while on the Alberta side SPC is laying 41 miles of gathering lines for the Many Island field. Local distribution systems, including laterals, total 151 miles, so that the grand total for the year will be 471 miles of all categories of lines.

Added to this impressive SPC total is another 125 miles being laid for Steelman Gas, Ltd., in the fields tributary to its gas recovery and processing plant now under construction in the Steelman oil field, to recover casinghead gas in large volume. Saskatchewan therefore will have almost 600 miles of gas line construction in the 1958 season.

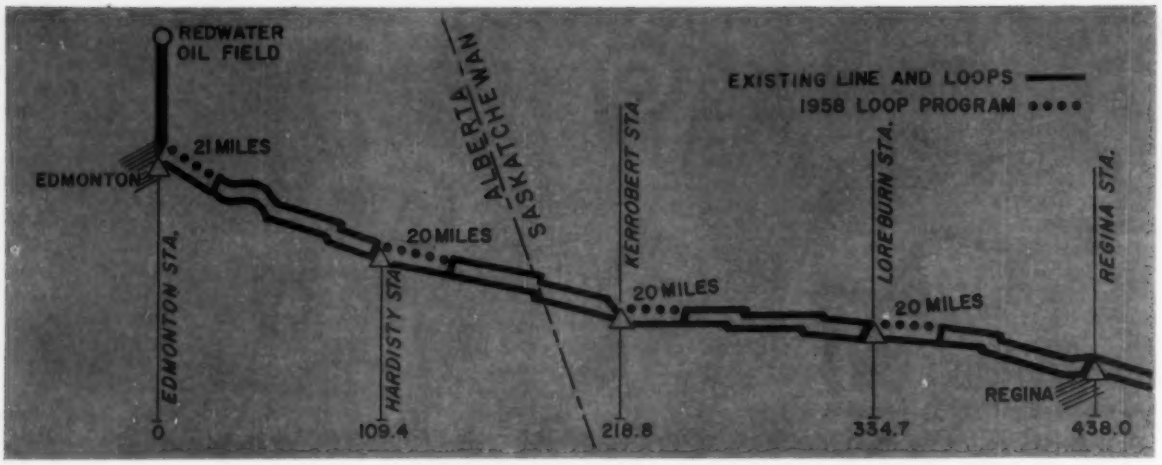
Alberta Gas Trunk Line

The principal natural gas project for 1958 in Alberta is that of The Alberta Gas Trunk Line Company, Ltd., a joint operation of the Alberta Government, producing and utility companies, which was set up a little more than four years ago, but has only been in actual operation for a year. Charged with the function of acting as intermediary between all the producers in the province and any pipeline companies moving gas outside Alberta, Alberta Trunk has the prospect of becoming the largest individual handler of gas in the whole of Canada.

The Alberta Trunk program for this year consists of about 250 miles of lines, all in the southern and southeastern sectors of the province. The principal portions are three major extensions of the main line. The first job is 50.2 miles of 34-in. to extend the main trunk transmission line back



Alberta Gas Trunk Line Company has prospects of becoming the largest individual handler of gas in Canada. This map shows its 1958 construction program.



Crude oil pipeline construction consists almost entirely of gathering lines this year in Canada. Interprovincial Pipe Line Company's looping job was the principal main line project.

westward from the point near the Saskatchewan border, which it reached last year in its progress from the provincial gate. The second item is 24 miles of 26-in. main line from the terminus of the 34-in. line northwestward to the Stevenville and Cessford gas fields. The third and largest unit in the program is 144.5 miles of 24-in. line to connect the Pincher Creek gas field in the extreme southwestern corner of Alberta with the junction point of the 34-in. and 26-in. lines.

Small laterals, designed to tie in four principal fields as supply sources in the eastern sector, will account for 19 miles of small-diameter lines ranging from 6 in. to 8 in. A concurrent program of housing construction will involve 24 staff houses at four locations, a district warehouse, instrument and field office, and a maintenance warehouse.

Both major Alberta utility companies have extensive plans for the current season. Northwestern Utilities, Ltd., which operates in the northern half of the province, is laying about 120 miles of line, of which 94 miles represent construction of the gas gathering system in the Pembina oil field, and the main 16-in. transmission line, which will move this gas to Edmonton for the city system. Five new towns will be added to the company's distribution network, and the continuing program in the city of Edmonton will add several hundred new services.

Canadian Western Natural Gas Company, Ltd., covering the southern half of Alberta, has as its major project the construction of a 55-mile 16-in. main transmission line from the Carbon gas field to the city of Calgary. The rest of its 1958 schedule contains provision for a lateral to the town of Vauxhall in the southeastern sector, and extensions of mains and services in the communities now served with gas. Altogether it will lay about 100 miles of lines.

Westcoast Transmission Company, Ltd., is extending its natural gas gathering system in the northern Alberta fields of the Peace River region by about 80 miles of various size lines, to increase the proportion of its contracted reserves that will be available next winter for movement through the main transmission line.

Alberta thus has a total of approximately 550 miles of gas line construction for 1958, closely approximating the amount of construction by SPC in Saskatchewan but lagging a considerable distance behind in overall total.

In British Columbia, with the main transmission line of Westcoast completed last year and the largest utility system, of Inland Natural Gas Company, Ltd., also placed in operation, only minor extensions are involved this year, mainly by British Columbia Electric Company, Ltd., the sole gas distributor in Vancouver. The total estimated construction adds up to about 100 miles, all of which is city distribution lines.

Compression Station Construction

In addition to the primary pipeline construction projects, a large program of compressor station construction is in progress for Trans-Canada, which this year will complete the first five stations in its planned program of enlarging throughput capacity. At Burstall, starting point of the 34-in. line, and at Caron and Moosomin, in central and eastern Saskatchewan, respectively, Trans-Canada is building identical stations of 10,200 hp each, with three large 3400-hp engines in each installation. At Winnipeg a 7500-hp station is being built, consisting of three 2500-hp units. At North Bay, Ontario, the smallest station includes 5400 hp in three 1800-hp units. All stations are scheduled for completion in the early fall, to coincide with completion of the main line in Ontario.

Crude Oil Pipelines

Crude oil pipeline construction this year is concentrated almost exclusively in Saskatchewan and Alberta, and consists almost entirely of gathering lines, as main line construction has slackened off to one major looping job on the Interprovincial Pipe Line Company main line.

This 82-mile 24-in. job is divided into four sections varying from 20 to 21 miles each. They are situated on the downstream sides of the Edmonton and Hardisty pumping stations in Alberta, and the Kerrobert and Loreburn stations in Saskatchewan. Their completion will fill in the only remaining gaps in the 24-in. loop line, to create the equivalent of two entirely separate lines all the way from Edmonton to Superior, Wisconsin, one mainly 16-in. and the other entirely 24-in. In addition, new pumping units, each of 2040 hp and diesel-powered, are being installed in the existing pumping stations at Regina and Glenavon in eastern Saskatchewan and at Cromer and Glenboro stations in western Manitoba.

The new station units will increase the capacity of the central portion of the line, which carries the increasing flow of Saskatchewan crude delivered by the South Saskatchewan and Westspur pipelines. Together with the loops, this will raise total throughput capacity to 275,000 bbl per day out of Edmonton, 379,000 bbl per day out of Cromer, and 261,000 bbl per day out of Superior. Increases for the next year or two will be anticipated by this construction program, which was due for

completion in the latter part of the summer.

The only other main line job scheduled for possible construction this year is the 125 miles of 10-in. line to be built by Federated Pipe Lines, Ltd., subsidiary of Home Oil Company, Ltd., from the Swan Hills oil discovery region to Edmonton. Although the necessary Alberta Government permit was issued in the spring, engineering and right-of-way surveys in the difficult muskeg terrain in the northern half of the proposed route delayed the calling of tenders until early July and the contract had not been awarded at the end of July. Financing also was to be arranged.

In southwestern Manitoba, Trans-Prairie Pipelines, Ltd., has laid about 10 miles of gathering lines to tie in new batteries, but the near suspension of Manitoba development drilling has almost put a stop to gathering system construction. In southeastern Saskatchewan Trans-Prairie is laying about 30 miles of gathering lines, in the Weyburn field area where it has an exclusive franchise.

The system of Westspur Pipe Line Company, spread over all the southeastern fields of Saskatchewan, will be extended by a total of about 100 miles by the end of the year, all consisting of new gathering lines connecting this year's completed wells. A few miles of gathering lines are being laid in the southwestern medium gravity fields, so that Saskatchewan's total minor line construction will add up to about 150 miles.

Alberta development drilling has also slowed down materially, and approximately 250 miles will cover practically all the gathering line construction for 1958. One of the larger jobs is the extension of lines in the big Pembina oil field, which will take about 100 miles. The other active fields, Innisfail, Bellshill Lake, Harmattan East, and Kaybob principally, will account for a total of a little over 100 miles.

An unusual job in the 1958 program is the laying of 20 miles of very high pressure stress-relieved pipe in the Pincher Creek field, to handle condensate from the wet gas that will be produced in fairly large quantity when the field goes on the line to the Trans-Canada gas system in the early fall.

The absence of any major field discoveries during the second half of last year and all of 1958 to date, in either Saskatchewan or Alberta, has affected the volume of gathering lines required. The total of slightly under 400 miles, combined with a little over 200 miles of main line work, makes a combined total of about 600 miles. ★ ★ ★

A 4-Ft Trench is Blasted Through 88 Miles of Hard Rock

Drilling for natural gas? Well, almost. Construction crews pictured here are operating a drilling rig near Sudbury, which bores two holes simultaneously through some of the hardest rock in the world. It's part of the construction of Northern Ontario Natural Gas Company's Sudbury lateral.

BETWEEN North Bay and Sudbury, Ontario, lie millions of tons of rock—the oldest and hardest rock in the world. Pipeliners for Northern Ontario Natural Gas Company, Ltd., are now at work in this area, blasting a 4-ft trench through 88 miles of what experienced engineers have called "the toughest pipelining country in the world."

Contractor on the big job is Mannix Company, Ltd., Calgary. Before they finish this fall, construction crews will have detonated an estimated 1200 tons of blasting powder, moved 60,000 tons of rock, employed 100 people — most of them from the Sudbury area — laid 485,000 ft of 10-in. steel pipe, and spent more than $4,000,000.

When they pack up at last, the Mannix crews will have laid a lateral pipeline that will carry Alberta natural gas 88 miles from a take-off point on the Trans-Canada Pipe Line near North Bay, and feed it into a system of mains now being laid under Sudbury streets. Along the way, the lateral also will feed gas into distribution systems in Copper Cliff and Sturgeon Falls.

Before a foot of trench could be dug, however, easement agreements, in which residents grant permission for the lateral line to cross their property in return for adequate compensation, had to be obtained this spring. Most residents, while not overjoyed at the prospect of having crews and heavy equipment working "in the back forty," put it down as one of the prices of progress, and were compensated satisfactorily.

Indians of the Nipissing Band, near Sturgeon Falls, for instance, after lengthy tribal consultations and conferences with Indian Affairs Department officials, were paid a tidy $25,000 for easement rights on a 50-ft wide strip of land running 23 miles across the Reserve.

After the lateral line is in the ground, they'll still be able to cultivate the strip, plant it, build sidewalks and fences across it, or use the land for practically any normal purpose, subject to permission of the gas company. Reserve residents will be employed on construction across the strip.

With right-of-way contracts procured, construction began in mid-June.

Construction crews hit the "tough spots" first; railway, road, and river crossings are tackled one by one, and usually completed before the "straight-line" construction begins.

At river crossings, pipe is weighted down with heavy concrete clamps, which keep the pipe in place on the river bed. In all cases, pipe with extra-thick walls is used at river crossings, as a double-check on safety.

Blasting is no hit-or-miss process, and highly skilled personnel with years of experience are required for the job.

A tractor with an attachment capable of drilling two holes at once bores into the rock at 1-ft intervals. Holes are 3-ft deep, and are capped with wooden pegs until just before blasting, to prevent crushed rock from sliding back into the hole.

Finally, holes are filled with a mixture of ammonium nitrate and blasting powder, and fired off with blasting caps.

In uninhabited stretches of the route, as much rock as possible is blasted at one time; in restricted areas, much smaller blasts are made, so the rock is chipped away piecemeal.

The Sudbury lateral — as are the distribution systems in Sudbury, Sturgeon Falls and Copper Cliff — is scheduled for completion for early fall.

The Trans-Canada Pipe line, with which the Sudbury lateral will connect, is scheduled for completion to Toronto by November 1 this year.

Northern Ontario Natural Gas Company Ltd. engineers plan to complete their section of the job well in advance of this date. ★ ★ ★

A portion of the pipe for new products pipeline from Wood River, Illinois, to Griffith, Indiana, stands ready for shipment in a rail center outside the Republic Steel plant at Youngstown, Ohio.

WABASH SYSTEM SCHEDULED FOR COMPLETION IN NOVEMBER

CONSTRUCTION of the new Wabash Pipe Line Company's 265-mile common carrier for refined products pipeline from the Hartford-Wood River, Illinois, area to Griffith, Indiana, started early in August. Anticipated completion of the line is early in November.

The Ohio Oil Company and Continental Oil Company formed the Wabash Pipe Line Company to build and own more than 350 miles of refined petroleum products lines in Illinois and Indiana. Ohio Oil holds 75 percent of the stock and Continental, 25 percent. Ohio Oil will operate the system under a management contract with the Wabash Pipe Line Company.

The new line will connect with an already completed Wabash products line extending 85 miles from Robinson to Champaign, Illinois. Ultimate capacity of the new 12-in. system will be from 90,000 to 100,000 bbl a day.

The approximate path of the new line takes it from the Wood River-Hartford area through Litchfield and near Decatur to outside Champaign. At this point the line will connect with the 12-in. line from Robinson to Champaign, completed June 15. From Champaign, the new line will continue through Delrey and Kankakee to Griffith, Indiana, near East Chicago.

During the early part of the summer, Republic Steel Corporation's Youngstown, Ohio, plant shipped 25,000 tons of pipe to nine locations along the proposed line. The 12¾-in. electric weld pipe was transported by rail cars and barges to the Illinois points. Rail cars transported the pipe to St. Louis, Bethalto, Mt. Olive, Pana, Bement, Lebera, Crescent City, Momence, and Hartsdale, preparatory to stringing.

The Illinois Commerce Commission granted a Certificate of Convenience and Necessity to the Wabash Pipe Line Company on July 18. Contract and Materials Company of Evanston, Illinois, has the contract for construction of the line.

Clearing of the right-of-way began the last week of July and road crossing started the following week.

Actual laying of pipe began the week of August 4, with about three months needed to complete the line. The line is being constructed by two spreads. One started at the southwest end and the other approximately 10 miles southwest of Champaign.

Outdoor Pump Stations

Outdoor electric pump stations are planned at Wood River, Robinson, Hartford, and Champaign, with others added later as needed to give the ultimate capacity of 90,000 to 100,000 bbl a day. Stations will utilize a power-saving fluid drive, which automatically adjusts pump speeds to the volume of oil in the line.

Wood River, Champaign, and Robinson stations each will utilize 1250-hp pumping units, with projected plans calling for an increase to 2500-hp. At Hartford there will be installed a booster station with a 300-hp unit.

The pipeline will make deliveries to a privately owned refined petroleum products terminal recently completed at Staley, near Champaign, Illinois. Wabash will also make deliveries at Griffith, Indiana, in the East Chicago area to a large, privately owned terminal being constructed.

One Section Completed

The already completed section of products line from Robinson to Champaign is connected to Ohio Oil's refinery at Robinson. At Wood River, the Wabash system will receive deliveries from the Cherokee Pipe Line system,

One of the 16 barges used to transport a portion of the 25,000 tons of pipe to Illinois by way of the Ohio River, is loaded at Monaca, Pennsylvania.

Construction of Wabash's 85-mile, 12-in., products pipeline between Robinson and Champaign, Illinois, was completed in June. Here, the pipe is being wrapped, coated, and lowered into the ditch.

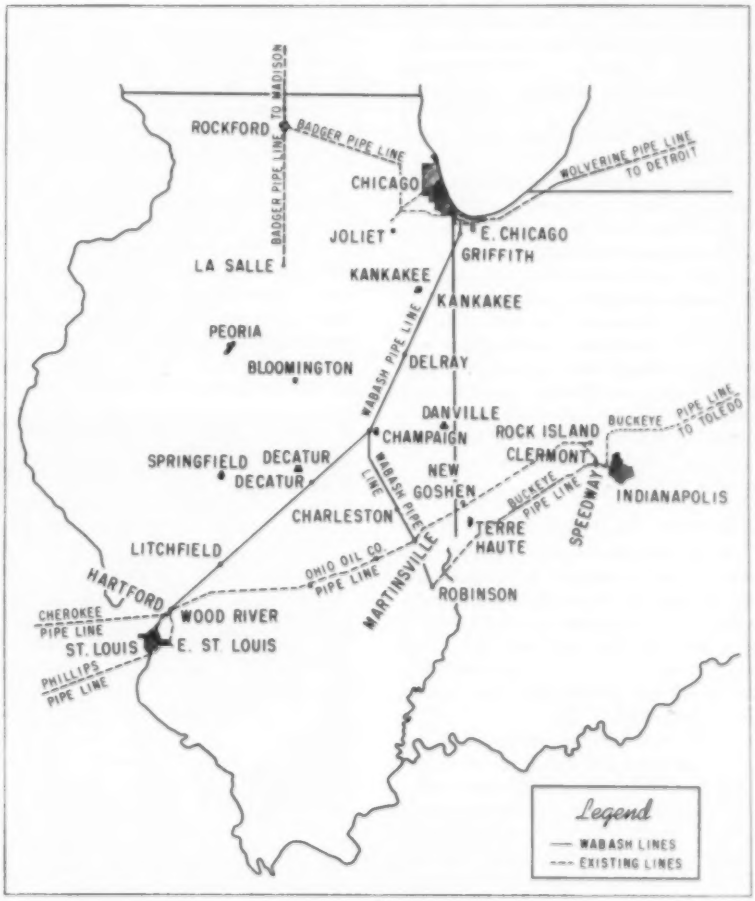
which is connected to the Continental and Cities Service refineries at Ponca City, Oklahoma, and DX-Sunray and The Texas Company refineries in the Tulsa area. Wabash can also take products from several large refineries in the Wood River-East St. Louis area.

Wabash will make deliveries to water loading facilities for shipment of refined products by canal to Chicago and by lake-going vessels to other Great Lakes ports. Wabash can also be connected to other products pipelines in the East Chicago area.

During construction of the new line, products will be moved from Wood River through the Ohio Oil Company's existing products line to Martinsville and then through the just completed Wabash line extending north to Champaign.

Directors of the Wabash Pipe Line Company are: J. H. Rice, K. E. Tappy, and C. A. Jackson of the Ohio Oil Company, and H. R. Wall, John L. Kelly, and W. L. Kygar of Continental. Officers and their affiliations are: J. H. Rice of Ohio Oil, president; R. M. Slough of Ohio Oil and W. L. Kygar of Continental, vice presidents; Calvin A. Brown of Ohio Oil, secretary; R. H. Brown of Ohio Oil, John D. Morrow, and P. J. Dominic of Continental, assistant secretaries; C. A. Jackson of Ohio Oil, treasurer; S. F. Nash of Ohio Oil and L. C. Peters of Continental, assistant treasurers. ★ ★ ★

Route of Wabash Pipe Line System extending from Wood River to Griffith and joined at Champaign by a line from Robinson, Illinois.



TRAINING SCHOOL HELPS SOLVE WELDER SHORTAGE

***Courses sponsored by Pipe Line Contractors Association* qualify 141 welders since first of year**

Richard A. Gump
Executive Secretary
Pipe Line Contractors Association

THIS SPRING the Pipe Line Contractors Association made a strong bid to ease the critical welder shortage that has seriously hampered the industry in recent years by training 141 new pipeline welders. U. S. and Canadian cross-country work has increased greatly, but the number of welders has not kept pace with demand. A 1957 rough estimate placed the number of pipeline welders in the U. S. at about 2460. A figure is not available on the number in Canada.

Some companies have been successful in training their own welders. The Pipe Line Contractors Association of Canada has been training welders in schools operated by the government at government expense primarily.

Overall, however, the distinctive nature of "down-hill" electric-arc pipe welding, along with increasingly high performance standards and the toll taken by the normal movement away from the industry of older welders and to plant work, have combined to create a critical shortage.

Solution: More Welders—Now

It became obvious to pipeline contractors in the fall of 1957 that from the amount of work on the horizon for 1958 there would be no slackening in the demand for welders. The only answer was to train as many welders as resources permitted prior to the 1958 season.

After considering several alternatives for welder training at minimum cost, the Pipe Line Contractors Association worked out an arrangement with the Petroleum Extension Service of the University of Texas. John Woodruff, director of Petex, as it is called, and Jack Mosley, who became coordinator of the Pipe Line Welding School, have had many years' experience with technical training in all areas of the petroleum industry. Their know-how proved invaluable to the school.

The cooperation of the Union—The Union 798 in Tulsa, was sought and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada — and of Pipeliners Local Union 798 in Tulsa, was sought and obtained. One of its representatives, Charles C. Balch, served on the advisory committee and contributed a great deal to the smooth working success of the school.

A site was selected at Kilgore, Texas, to be near Kilgore College, and facilities set up in a new building, having room for ten welding booths inside, 20 welding machines outside the building, and plenty of surrounding ground for pipe storage.

The first of the three six-week classes began in mid-January, 1958, with 48 students. Instruction was given in two shifts of eight hours each, six days a week, providing a minimum of 288 hours of instruction and welding practice for each student. The final class was completed at the end of May, just before the work season began — leaving a minimum of time for newly-learned welding skills to get rusty.

Training was specifically designed to enable students to qualify under API Standard 1104, "Standard for Field Welding of Pipe Lines." Thus, the emphasis was to give each man as much actual pipe welding practice as possible, to — as API Standard 1104 puts it — "produce the highest quality weld obtainable on a commercial basis . . . using approved welding procedure, materials and equipment." The 50,000 lb of welding rod and the quantity of pipe used for practice attest to the amount of practice by students.

The API-AGA Joint Committee on Oil and Gas Field Pipe Line Welding Practices, chairmaned by Robert G. Strong, cooperated by sending two qualified welding inspectors, one from an oil company and one from a gas company, to test at the end of each class all those completing the course. The assistance of these inspectors to the school actually went beyond testing students; their comments and suggestions proved invaluable in improving the quality of welds and techniques of welding. Those who helped in this respect are: C. T. Allen, Joe Blackshaw, W. A. Burton, C. R. Kersey, O. S. Mauck, and Leo Pindjak.

The school's faculty taken at farewell dinner. Left to right, Jack Mosley, coordinator, and instructors James W. Romans, Ernest C. Lewis, Donald F. Moon, Thomas G. Owens, C. D. Richardson, and Benjamin J. Grace.

Inside the building used for the school there were ten welding booths with two places in each booth. Instruction was given in two shifts of 8 hours each, six days a week.

A part of the training was instruction in the use of the cutting and beveling machine.

Selecting the Students

Based on past experience — the Pipe Line Contractors Association participated in welder training schools in 1950 and 1953, training a total of 200 welders — it was expected that 100 to 125 students would qualify under API Standard 1104. The fact that 141 out of 144 students did qualify is due in large part to careful selection of candidates for the school.

A committee composed of three representatives of the Pipe Line Contractors Association and one representative of the Pipefitters Union reviewed the applications of candidates recommended by individual contractors and U. A. Pipeliners Local 798. Many hours were spent comparing backgrounds of the 343 prospective students.

Basic criteria for selection were: (1) Some previous pipeline construction experience, preferably as a welder helper, or other welding experience, and (2) young enough to have a long career in the industry and justify the $800 plus per student cost* of training — including $50 a week to each student for expenses. Thus most students were in their twenties, with a few in their early thirties.

Apparent to any visitor at the school was the infectious enthusiasm of both the students and instructors. It was not uncommon, according to Jack Mosley, school coordinator, for students to return 15 minutes early from a 30-minute lunch period to get back to welding pipe. Many Sundays found students and instructors in the welding booths.

On the walls near welding booths were cartoons depicting the problems of students and the old-time pipeline welders drawn by instructor Donald F. "Doc" Moon — displayed alongside diagrams of welding and testing standards from API Standard 1104. Instructors Benjamin Grace, E. C. Lewis, Donald F. Moon, Charles D. Richardson, James W. Romans, and Glenn Owens worked hard to give each man every chance to qualify, sometimes changing a trainee from one instructor to another if they felt it would help him.

The attitude of the trainees was perhaps typified by the comment of one student in the first class, "There were 400 guys out there on our spread, and they picked just four of us to go to welding school. I'm sure not going to miss this opportunity!"

Apparently the enthusiasm was also felt by a welding inspector from one of the large operating companies, who commented that he was "quite impressed with the product turned out" by the school and felt that "under good supervision, any one of the graduates would make it on a construction job." He also stated that the school was well organized and had capable instructors.

Proof of the Pudding

Just how much the Pipe Line Welding School accomplished will, of course, be told in the careers of its graduates. Successful graduates were presented a wallet-sized certificate of completion as identification. Former students have been asked to keep the Pipe Line Contractors Association advised of their progress. Contractors also have been requested to give these boys a hand and make it a point to report to the association on each man's progress as a welder. Preliminary reports by foremen on the few boys now working are very encouraging.

It was not expected that the addition of these 141 new men to the supply of pipeline welders would end the welder shortage. But if these new welders can be used while their training and experience are still fresh, the Pipe Line Welding School will have made a contribution toward solving some of the pipeline welding problems.

It seems that they will be, for the API-AGA Joint Committee on Oil and Gas Pipe Line Field Welding has amended API Standard 1104 to include a clause to qualify for limited service those who successfully completed the school. The limited service clause reads:

"Welders of limited experience may be qualified for work of a specific nature. They shall be assigned to nonpressure welds and to completion of pressure welds that have the root and second pass made by fully qualified welders. They shall be subject to strict inspection, but shall be granted every consideration and assistance consistent with acceptable pipeline welding practice."

Both the Pipe Line Contractors Association and the union recognize the need for a continuous program of welder training and are now studying the proper procedure to keep the program going on a smaller but continuous basis.

Training Schedule

Jack Mosley, who prepared and administered the training schedule, has provided the following outline of the step-by-step procedure, and comments on some of the experiences of students and instructors:

1. Start and adjust machine. The school had 17 gasoline-driven electric arc generators and three diesel generators. The gasoline driven generators, of course, took much less time to instruct in starting. The diesels, especially in cold weather, were harder to start and operate. Interestingly, one of the problems encountered by students

*This represents the financial cost of the training borne by the members of the Pipe Line Contractors Association. Some funds and equipment and the pipe for practice welding, most of which was supplied by operating companies, also made real contributions to the success of the school.

Electric welding machines were placed outside the building with the cable extending through the wall. There were 20 welding machines in all.

in starting the gasoline machines was not properly cranking it — students tried to spin the crank rather than merely lift it, which is a violation of safety regulations. Students learned the hard way that adjustments for desired settings varied on each machine and that a control knob indication had little meaning unless you had worked with the machine and understood it. Total time this instruction — 2 hours.

2. Strike and hold an arc. Two methods taught: (1) Packing or tapping, (2) dragging or scratching electrode. Beginners with no welding experience had to learn the three-motion coordination — feed electrode toward work, incline electrode at proper angle, and move electrode ahead, simultaneously. To pass this part of the training successfully, a student had to burn a full electrode without breaking arc. Training time — usually a "few hours" to 5 days (extreme).

3. Straight bead — flat. The student simply welded straight, parallel beads on top of the pipe. Welding was checked for uniformity of bead, not cracked, no overlap on sides, smooth.

4. Lace pass. Student learned to clean the bead run previously and put on a smooth cover pass.

5. Straight bead, vertical position. Here the student faced the difficulty of slag trying to run ahead of deposited metal. Some tried to speed up ahead of the slag and left pockets and slag inclusions with some skips.

6. Lace bead, vertical. Similar to No. 4 except that it was, of course, on the side, or vertical part of the pipe. Poor cleaning of the previous bead showed up here in poor weld quality.

7. Straight bead, overhead. Students learned that they had to hold a much shorter arc in overhead welding, that there was no gravity helping to carry the molten electrode to the metal. Now only the force of the arc carried metal across the gap. They learned that it was hard to carry a large puddle. One student said, "It's no trouble putting metal on overhead, but it keeps dripping off on you."

8. Lace bead, overhead. Similar problems to No. 7 but had to carry a weld of greater width, carrying more metal in a given area.

9. Space and tack nipples. Space was critical. Some beginners set the nipples too close and didn't get sufficient penetration. Others set them too far and got "windows" in the stringer bead. Proper alignment of the pipe was shown to be absolutely necessary.

Warping, or contraction, of weld nipples sometimes narrowed the spacing and dictated the use of ⅛-in. electrodes for stringer beads instead of 5/32-in. electrodes normally used. Some students required quite a bit of time learning to make good tack welds that could be welded-over on the stringer bead without slag lines, incomplete fusion zones, and pockets.

10. Stringer bead. In addition to the comments on step 9 above, students were impressed with the necessity for proper land, line-up, and spacing of nipples.

11. Hot pass. Many troubles resulted early in a student's training in this phase of welding, which resulted from his insufficient cleaning of stringer bead and insufficient heat for the hot pass. They had to learn to keep the hot pass as flat as possible rather than leaving a bulging or rounded bead, which can cause slag inclusion or incomplete fusion on each side of the weld.

12. Filler beads. Generally there was no great difficulty with filler beads if the hot pass had been properly cleaned with a wire brush, and, if necessary, an ice pick. The filler beads, of course, bring the pipe weld out to the point where the cap or finish pass is made.

13. Finish pass. Now the students had to carry a wide bead, going more slowly with the heat not dissipated so fast and the bead therefore not solidifying so quickly. It took considerably more skill to do a straight weld smoothly, of good appearance, and of the right width on this finish pass which, of course, has no "V" to hold the metal.

Considerable practice was required on the finish pass, not so much to make a sound weld as to give it a good appearance, since this is the only part of the weld the inspectors often see. Considerable practice was necessary, particularly on the larger sizes of pipe.

14. Test welds, 6-in. to 10-in. pipe. The difficulty of welding increases as the size of the pipe increases. Thus, tests were made as welding was done on progressively larger sizes of pipe. In the initial testing only nick break tests were made to enable the instructor to examine the interior of the weld and tell what the student needed to do to improve.

Some students were able to begin preliminary tests such as this in two weeks or less; others began tests after as much as four weeks.

15. Test welds, 12-in. to 20-in. pipe. It is harder to weld larger pipe. Of course having to change the electrodes creates a problem, as it is easy for a beginner to leave faults where he begins with a new electrode, or to strike an arc on the pipe rather than the weld, thus creating bad stress concentrations on high tensile pipe.

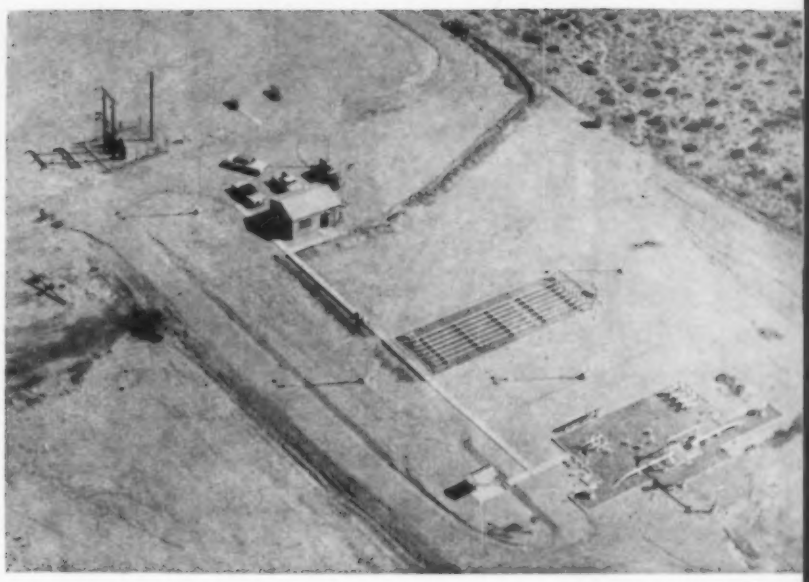
16. Test welds, 20-in. to 30-in. pipe. Problems are similar to those above except that more vertical and overhead welding was necessary, increasing the difficulty of the weld.

17. Hillside welds. When each student had finished the foregoing training and testing, he was given practice on welding pipe moved up to 45 deg from the horizontal, simulating the field welding of pipe on a hillside.

18. Hand cutting. Each student was given a minimum of practice in hand cutting. It was done only as necessary to get practice lengths of pipe, to cut coupons, and to learn burning of holes and beveling edges of hole and pipe for lateral connections.

19. Beveling machine. One group of four students would bevel for the other 20 of his group who were welding. No particular difficulties were noted in teaching each man to operate the machines, though some practice was needed by most men to operate the beveling machines at their greatest efficiency.

20. Certified API Standard 1104 Test. All phases of the API Standard 1104 destructive test were given by welding inspectors employed by operating pipeline companies whose cooperation was obtained through the assistance of the API-AGA Joint Committee on Oil and Gas Field Welding Practices. ★ ★ ★



Pressure reducing station at Kingman, Arizona. Because of the drastic change in line elevation (from 6690 ft at the highest point to 15 ft at terminus) two stations of this kind were required.

FOUR CORNERS PIPELINE DESIGNED for COMPLETE AUTOMATION

This new system can be operated over its entire length from Los Angeles terminal

Frank H. Love, *Editor*

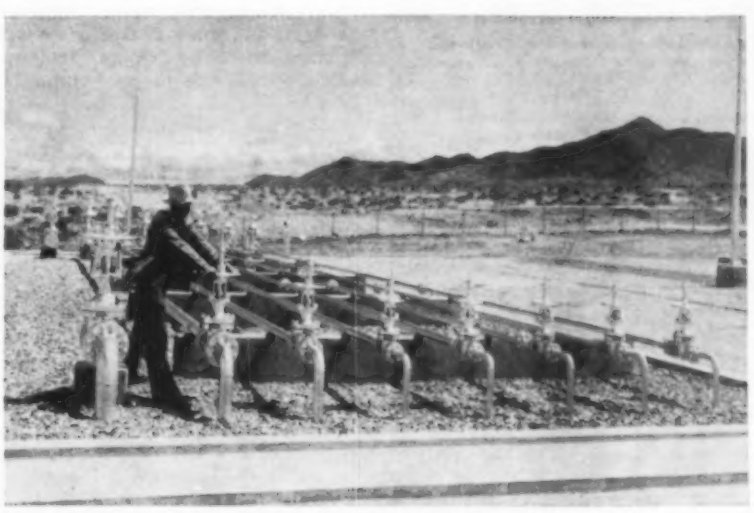
WHEN THE FOUR CORNERS PIPE LINE went into operation in April, after approximately 10 months' construction time, it gave the area after which it was named its first pipeline outlet. The Four Corners area, of course, is that prolific producing region where the states of Colorado, Arizona, New Mexico, and Utah meet.

The pipeline originates in the Aneth field of Utah and terminates in the Los Angeles Basin, supplying crude oil to a number of refineries in that area.

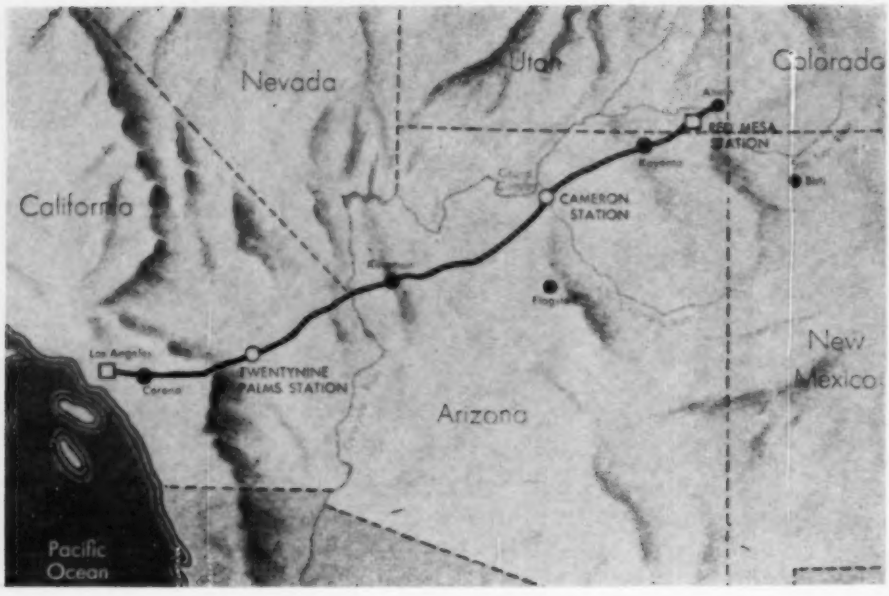
Initial capacity of the system is 70,000 bbl a day with three pump stations. Ultimate capacity will be 160,000 bbl a day with 14 stations. These capacities are based on 50 SUS viscosity, 0.825 specific gravity crude, and 97 percent load factor.

These are the outstanding features of the line:

- As designed the entire system can be operated remotely from the Los Angeles terminal — the first time a pipeline of this length has been so designed and constructed.



Heart of the pressure reducing stations is a series of pipe bundles, which create friction thereby reducing pressures caused from gravity flow.



Route of the Four Corners Pipe Line from Utah to California. Pumping stations are at Red Mesa, Cameron, and Twenty-nine Palms; pressure reducing stations at Kingman and Corona.

An unusual engineering operation is this span across the Little Colorado River near Cameron, Arizona. The pipe, 16-in. diam and 660-ft in length, is carried in the overhead trusses of an existing highway bridge.

● Pressure reducing stations were required because of the drastic changes in line elevation. At the originating point in Utah elevation is 5270 ft, at the terminating point in Los Angeles County it is 15 ft, and in between it rises to 6690 ft at Marsh Pass, Arizona. Without a means of reducing pressures built up by gravity flow serious trouble would result.

A microwave communications system carries the supervisory signals that make it possible for the dispatcher's office to control main line pump stations, pressure reducing installations, booster pumps, tank-filling and suction valves, and valves at delivery points. Additionally, at most leases custody of the crude is transferred automatically.

The Four Corners system consists of 618 miles of 16-in. main line and a gathering and feeder system that includes 147 miles of 4 through 16-in. pipe. There are three main pumping stations, 15 feeder stations, and two pressure-reducing stations.

Main line stations are at Red Mesa, Utah, Cameron, Arizona, and Twenty-nine Palms, California. The pressure reducing stations are near Kingman, Arizona, and Corona, California.

Equipment at Red Mesa station consists of one 2-stage and one 3-stage vertical centrifugal pumps driven by 150-hp vertical, explosion-proof 1800-rpm synchronous speed induction motors, and three 2-stage centrifugal pumps driven by 900-hp, 3600-rpm forced base ventilation induction motors. As this is a receiving point, four 55,000-bbl tanks were installed here.

At Cameron station there are three 2-stage centrifugal pumps driven by 900-hp, 3600 rpm synchronous speed induction motors. The motors are weather protected, have built-in air filters, and are rodent proofed.

Twentynine Palms station has two 2-stage centrifugal pumps, one driven by a 900-hp, 3600-rpm synchronous speed induction motor, the other by a 150-hp, 1800-rpm synchronous speed, totally enclosed, fan-cooled induction motor. The 900-hp motor has a built-in air filter and is rodent proofed.

Pressure reducing stations at Kingman and Corona consist of friction bundles or pressure-dissipating tubes. Each bundle consists of 2 or 2½-in. pipe 65 ft in length with three sections of ¾ or 1-in. tubing welded inside the larger pipe. There are four friction bundles at each station, arranged parallel. Crude can be made to flow through one bundle, or through one, two, three, or four of the bundles. The purpose in varying the number of bundles is to better regulate the pressure differential from suction to discharge. Pneumatically operated control valves, arranged in series with each friction bundle, further aid in control of the pressure differential. And to further increase flexibility, three additional pipe sections, which do not have friction tubes welded inside them, are arranged in parallel with the friction bundles.

A relief tank has been provided at each pressure-reducing station, and should the upstream or downstream pressure exceed a predetermined value because of equipment failure, oil will be diverted to this tank.

Communications System

The microwave system provides talking, supervisory control, and telemetering channels, and extends from Farmington, New Mexico, to Los Angeles. There are seven microwave terminals, five junction stations, and three repeater stations.

Terminals are at Farmington, New Mexico, Red Mesa, Utah, Cameron and Kingman, Arizona, Twentynine Palms, Corona, and Los Angeles, California. Junction stations are at Roof Butte, Mt. Elden, Mt. Hualpai, Tip Top Mountain, and Butler Peak. Repeater stations have been located at March

Pass, Bill Williams Mountain, and Granite Mountain.

VHF radio base stations are provided at each of the microwave junction and repeater stations, and give voice communication with mobile radio equipment in management and supervisory cars.

Construction of the repeater stations presented a problem in logistics because of their comparative inaccesibility at mountain top locations. The fact that they were installed at a time of the year when snow covered these areas compounded the difficulty.

At one of the locations — Roof Butte — airlift was employed, believed to be the first time such a procedure has been utilized. It would have been almost impossible to get the equipment in by other means, and, also, it was felt that there would be less likelihood of its becoming damaged enroute. At some of the other repeater stations on mountain peaks, materials were transported the last 800 ft or so by mule pack.

Pipe gang working south of Sunnymead, California. Workmen in foreground are getting ready to line-up a pipe joint for the tack weld.

Construction

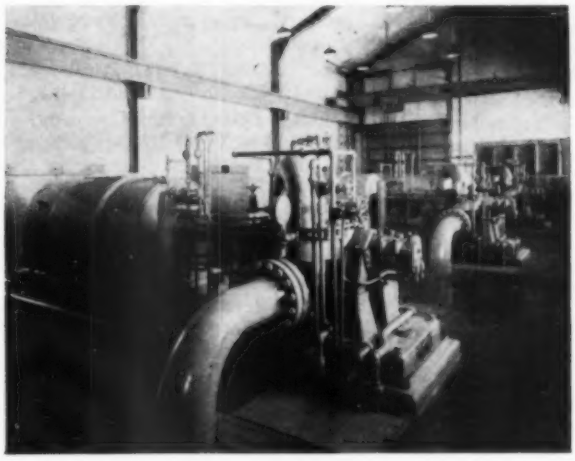
Possibly no other pipeline ever built presented such a complete set of construction problems. In southeastern Utah and northern Arizona the terrain was rocky and mountainous, in eastern California — desert, and in Los Angeles County — congested city streets and other municipal obstacles. Thousands of feet of ditch had to be blasted from solid rock, 10 water crossings made, and at one point mine detectors were used to clear a route across an abandoned army artillery range.

The Little Colorado River crossing was installed on an existing highway bridge at Cameron, Arizona, and the Los Angeles River was crossed on the Union Pacific Railroad bridge. Underground crossings were made of the San Juan, Colorado, Whitewater, Santa Ana, and San Gabriel rivers, and two locations on the Dominguez Channel.

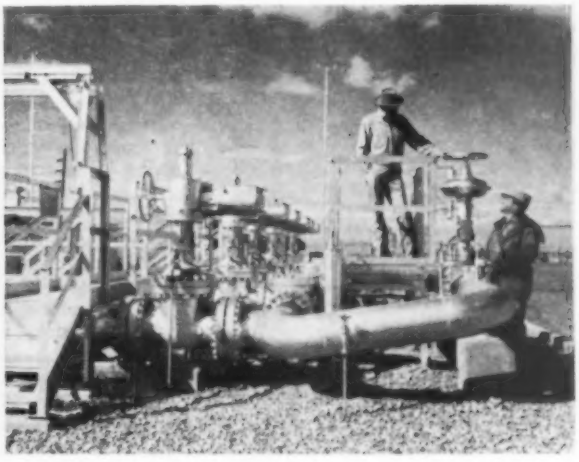
The crossing of the Little Colorado River was an unusual engineering operation. This span was installed in overhead trusses of a vehicular bridge just at the edge of Cameron on U. S. Highway 89 in a little over two weeks. The 660-ft section of 16-in. pipe weighed more than 54,000 lb. The manner of construction was to slide the 40-ft joints of pipe into the trusses one at a time and weld. The crossing is 84 ft above the stream bed at one end and 104 ft at the other.

The Colorado and San Juan rivers were tough ones because of their swift current. In fact, previous attempts to cross the Colorado River at Needles, California, had met with failure, the 6 knots per hour current filling up the ditch as fast it could be dredged. This time, however, after many weeks of struggle, the crossing was successfully made.

Pipe used on all crossings was Grade X-42 with wall thickness of ½ in. Ex-



Interior of Red Mesa station, the initial station on the system.



Manifold system at Cameron, Arizona, station.

Welders making a tie-in on California end of system.

Microwave repeater station on top of Mount Williams near Williams, Arizona. Deep snows and high altitude presented serious construction problems.

cept for the Colorado River and Little Colorado River crossings, the pipe was given three alternating coats of 2/32-in. thick enamel and glass fiber reinforcing followed by a layer of felt.

The Colorado River crossing was given a double coat of coal tar enamel, glass fiber reinforcing, and a felt wrap followed by 1-in. minimum thickness of concrete. The crossings carried on bridges were painted only with a primer, as the pipe will not be subjected to the corrosive conditions of buried pipe and can be inspected easily.

On other portions of the system pipe was coated with a single layer of enamel having a minimum thickness of 3/32 in., into which glass fiber wrap was drawn, followed by impregnated asbestos felt. An exception was 45 miles of pipeline laid in the Los Angeles area. Here Somastic coating was applied to nominal thickness of 9/16 in.

Both asphalt and coal tar enamels were used.

Specifications called for a ditch 30 in. wide and to a depth that would permit 36 in. of cover for the 16-in. pipe on the main line, except in rock where blasting was required and here the cover was 12 in. In these rocky areas a 6-in. padding of backfill material free of rocks and other hard objects was placed in the bottom of the ditch, and another 6-in. pad around and on top of the pipe after lowering in before the rest of the ditch was backfilled. As further protection to the pipe rock shields were placed along the sidewalls of the ditch during lowering-in.

Welds were spot checked by X-ray. Overall, the number of welds so checked averaged about 15 percent.

The line was tested hydrostatically in sections as construction progressed. Some 235,000 bbl of water were pumped into the system from the San Juan River in Utah and the line pressure-tested in sections between block valves. Crude oil was pumped into the line behind the water to displace it after testing and provide line fill.

Cathodic protection has been given the line and station equipment. Rectifiers were installed at all stations, as well as at intermediate locations. In the Los Angeles area magnesium anodes were installed. Insulating flanges are provided at stations, main line block valves, and other strategic points such as future station sites, delivery junctions, and some of the river crossings.

Major Contractors

The system was divided into nine sections for purposes of contracting line construction. Contracts were let as follows:

APV Company, Inc., and R. B. Potashnick — Sections 1 and 2, approximately 168 miles of 16-in. from Aneth field to Cameron station; 26 miles of 16-in. in Section 4 from El Paso Junction westward, and 88 miles of 12-in., Section 8, from Bisti field, New Mexico, to Red Mesa station.

R. H. Fulton & Company—Sections 3, 5, 6, Colorado River crossing, and remainder of Section 4; overall 400 miles of 16-in. extending from Cameron station to Olive, California.

Pacific Pipeline Construction Company — Section 7, 45 miles of 16-in. in the Los Angeles area, from Olive to Los Angeles. Also valve stations and delivery points in Los Angeles area.

Standard Pipeline Construction Company — Section 9, consisting of 40 miles of 4, 6, 8, and 10-in. gathering and feeder lines.

Station contractors were:

Station Construction Company — Red Mesa station.

Engineers Limited Pipeline Company—Cameron station, Kingman and Corona pressure-reducing stations.

Macco Corporation — Twentynine Palms station.

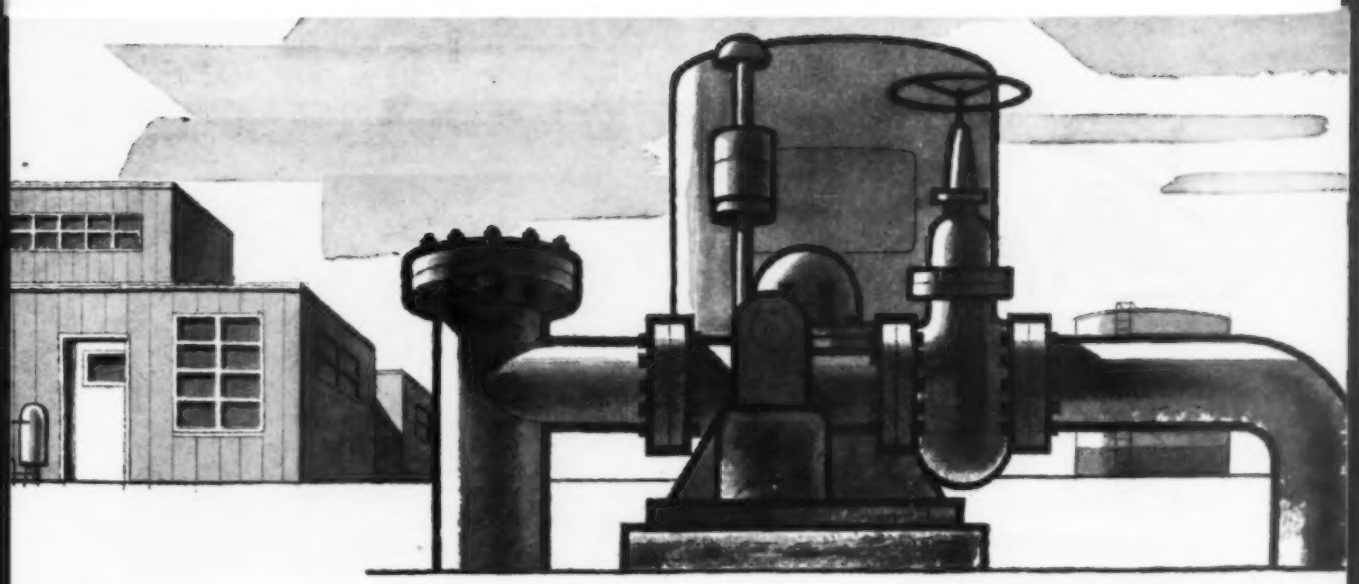
Los Angeles terminal and office building — Diversified Builders, Inc.

Chicago Bridge & Iron Company — 55,000 bbl tanks at Red Mesa, Kingman, and Corona.

Owners and Operators

Four Corners Pipe Line Company is owned by Shell Oil Company, 25 percent; Standard Oil Company of California, 25 percent; Gulf Oil Corporation, 20 percent; Continental Pipe Line Company, 10 percent; Richfield Oil Corporation, 10 percent, and Superior Oil Company, 10 percent.

Shell Pipe Line Corporation was in charge of construction and is operating the system. ★ ★ ★



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Control unmanned booster stations with new packaged control system

Designed by the pipeline industry for the pipeline industry

FEATURING:

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- **Modular construction**
- **Economy**

For years, now, Union Switch & Signal has been designing custom supervisory control systems to solve individual problems for pipeline companies. Out of this experience has come a realization of your requirements and the need for a simple standardized system capable of easy expansion . . . with the lower-cost advantages of package design being passed on to you. That system is now available.

This new modular control system concentrates all apparatus for the supervisory control of a station on two 19"-wide racks. One rack goes in the controlling office, the other at the field location being controlled. It provides display of indications and alarms and can easily be adapted to handle telemetering and other data. Future additions or changes to the system can be made without changing the basic circuits.

Security as well as conventional reliability

Rugged, industrial-type control components—designed and built by Union Switch & Signal itself—give this system the reliability you need in pipeline operation. But it goes further than mere reliability. Like other UNION Control Systems, this new system checks itself against error before implementing a control.

It is coded so that noise or distortion cannot operate the field equipment. It checks this code to insure correct operation. It immediately gives an indication if a communication failure occurs at any time.

This is the system you need to insure fail-safe operation. It is the system you need to trim the cost of single station controls. Write for complete information. And watch for future standardized systems now being developed by Union Switch & Signal.

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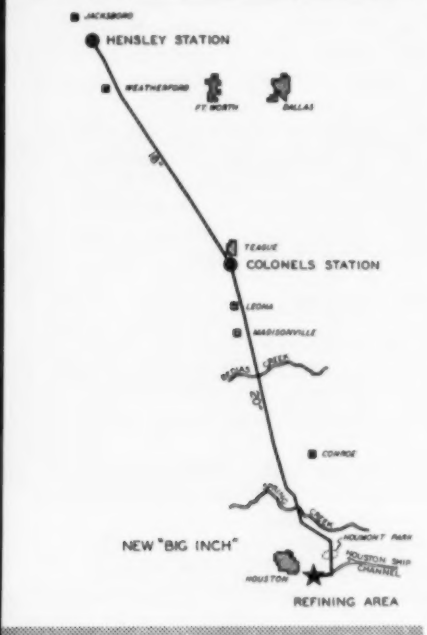
PITTSBURGH 18, PENNSYLVANIA

Replacement of smaller parallel lines with "big-inch" pipe accomplishes increased system throughput and greater economy of operation

Tie-in crew at work on new Sinclair 20-in. crude oil line in East Texas' "Piney Woods."

SINCLAIR'S FOUR-PHASE BIG-INCH PROJECT

J. R. Ligon
Assistant Chief Engineer
Sinclair Pipe Line Company



Route of Sinclair's new "big inch."

IN THE INTEREST of increased throughput looking to future expansion and greater economy of operation, Sinclair Pipe Line Company began a study in 1952 of the feasibility of replacing its small diameter dual line pipeline system from North Texas to the Gulf. A route from Jacksboro through Teague to Houston was laid out and collection of engineering data was begun. Preliminary engineering data consisted largely of ascertaining the location of future lakes, future superhighways, and proposed highway improvement programs.

Sinclair looked at the project to be accomplished as four separate operations. The first phase was to replace two side-by-side 8-in. lines from Jacksboro to Teague with an 18-in. line. The second phase was the replacement of parallel 8-in. and 12-in. lines from Teague to Huffman and parallel 12-in. lines from Huffman to Houston with a single 20-in. pipeline. The third phase was to replace an outmoded diesel station at Jacksboro with an all-electric station including additional tankage. The fourth and final phase was the replacement of the antiquated diesel station at Teague with a dual-fuel diesel station with increased tankage.

In the last quarter of 1954, Sinclair management issued approval for the first phase of the project. Purchase of right-of-way on the segments from Jacksboro to Teague and Houston to Teague began in September 1955, the latter including the congested areas of Harris County where difficulty in acquisition might be expected.

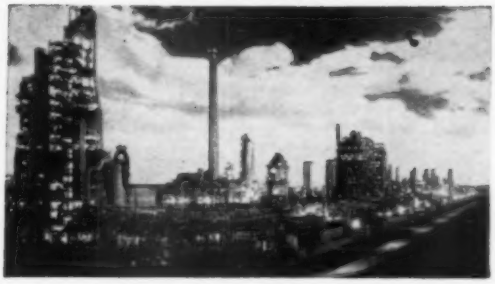
Contract for the construction of the Jacksboro to Teague section was awarded River Construction Corporation of Fort Worth, Texas, in January 1956, with actual construction operations beginning on January 16, 1956.

The line was completed and in operation by May 1956. This line consisted of 18.25 miles of 18-in. OD, 0.312-in. wall, grade 5LX-52 line pipe, and 133.72 miles of 0.281-in. wall, 18-in. OD, grade 5LX-52 pipe. This line was coated with asphalt enamel and wrapped with glass fiber and Kraft paper by the over-the-trench method.

All county and state maintained asphalt or concrete roads were encased with 22-in. casing. The line has been in continuous operation without shut down from mechanical, defective material or other failures.

Selecting Line Location

The second phase of the project was begun in June 1956. A line location between Teague and Houston was selected paralleling an existing 16-in. line for approximately 75 miles along the same right-of-way. This decision



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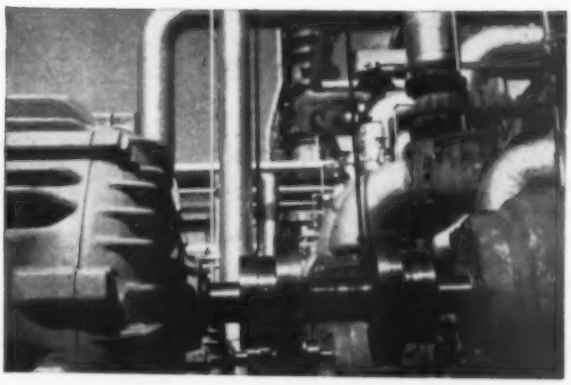
Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3207 Scott Street, Baltimore 3, Md.



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THE ORIGINAL
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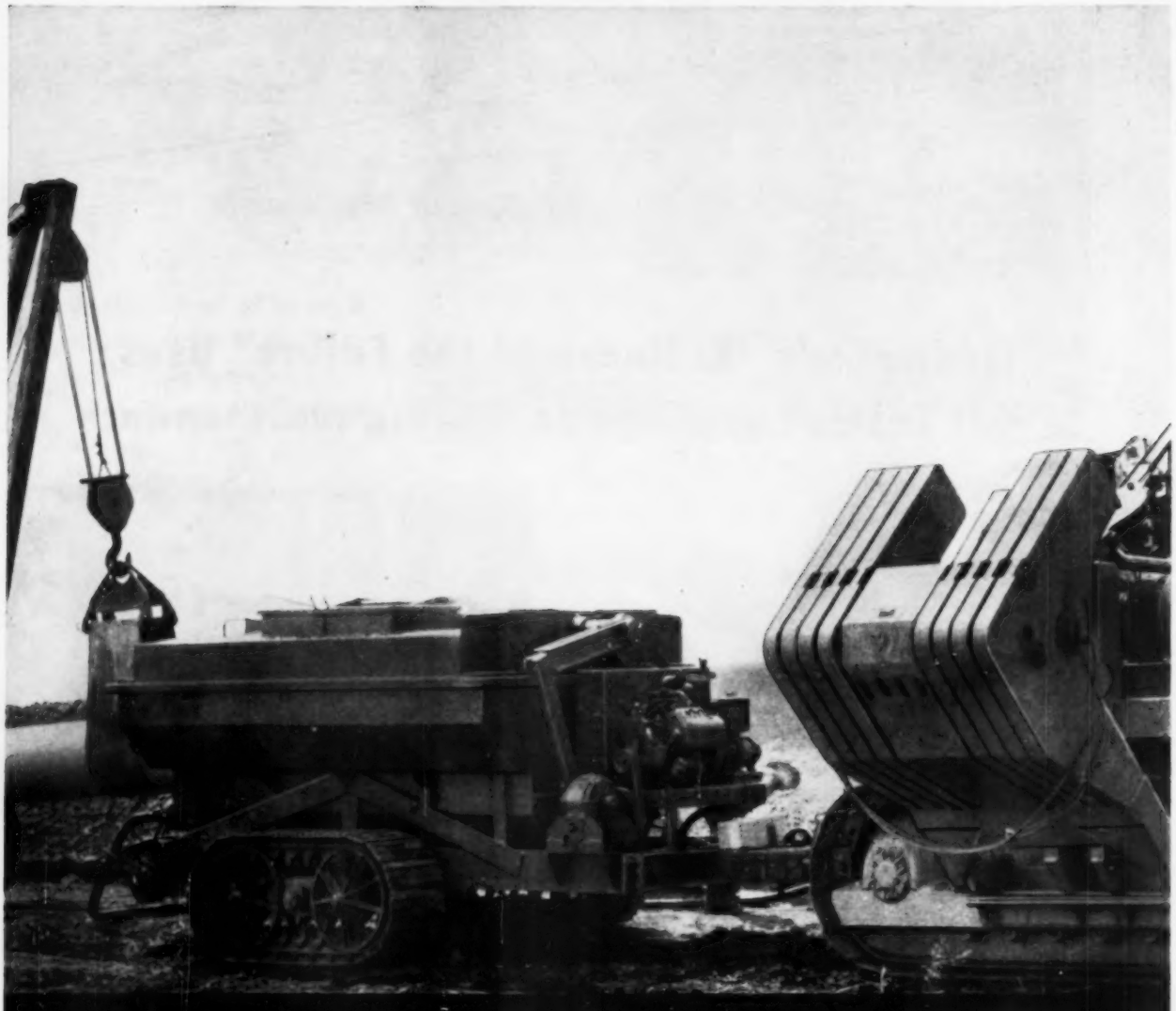

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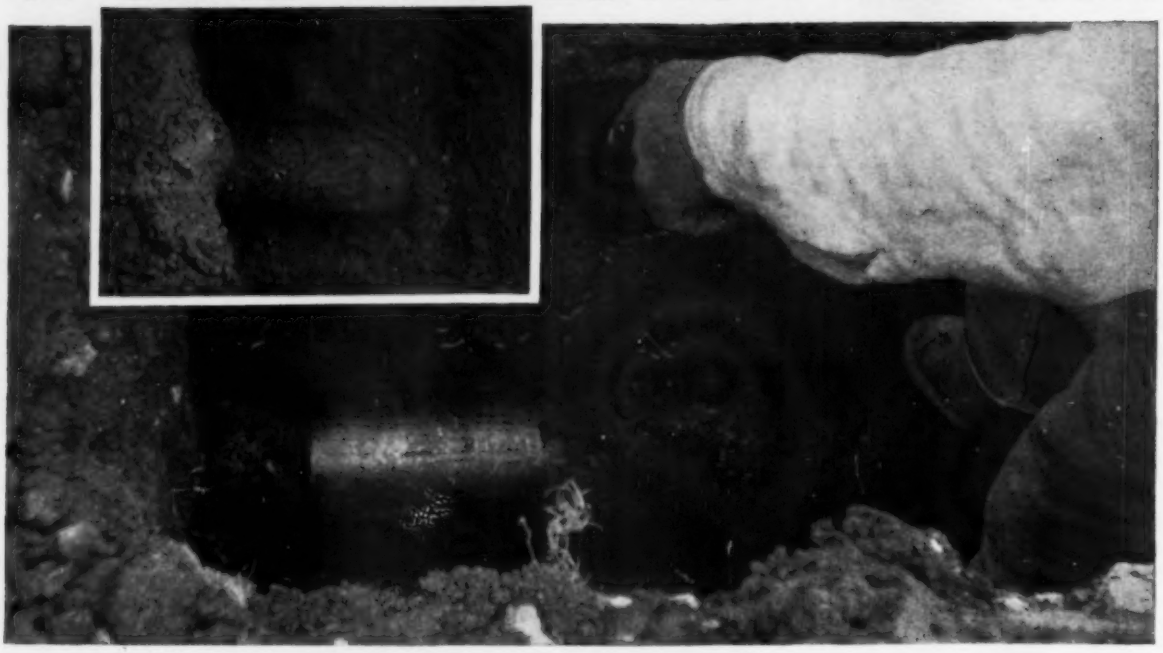

Year After Year...More Evidence Proving That TAPECOAT Adds Years of Service Life to Gas Lines Underground or Under Water

Right across the country, TAPECOAT installations prove that you get more for your money when you measure pipe protection with a calendar.

Since this cost-cutting coal tar coating in tape form was first introduced in 1941, it has demonstrated its ability to withstand severe conditions underground or under water. TAPECOATED lines dug up after 17 years of service show no signs of deterioration on the pipe.

Typical is the experience of a utility in a coastal area. For a thorough trial, this company applied TAPECOAT in areas where severe corrosive conditions were known to exist. The lines were dug up this year and, after years of service under severe conditions such as brackish waters and corrosive soil, the pipe showed no signs of corrosion, proving the quality of TAPECOAT protection.

In terms of preventive maintenance and replacement costs, performances like this emphasize the most important consideration in buying protection. Remember, TAPECOAT is a hot-applied coal tar coating in tape form—designed for lasting protection on pipe, pipe joints, service connections, mechanical couplings, fittings, insulated lines, tanks, tie rods, and other steel surfaces vulnerable to corrosion.

TAPECOAT comes in rolls of various widths and is available in asphalt. Where primer is desired, specify TC Primecoat, the compatible coal tar primer.

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explosion-proof, dust-proof cable connector

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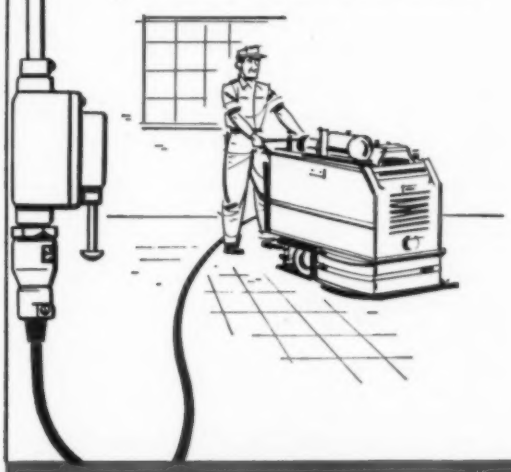
A factory-sealed, explosion-proof connector used between a portable extension cord and an explosion-proof unilet or housing

Illustration shows an APPLETON "ECC" Explosion-Proof Cable Connector in use with a portable Floor Scrubber.



From its rugged aluminum housing which withstands years of extreme rough usage, to its lead wires protruding 12" from the body for faster, easier splicing, this APPLETON "ECC" Connector has every desirable quality feature.

The current carrying lead wires for example, are solidly moulded into the connection blocks: can't work loose under vibration. An auxiliary cord clamp is provided to prevent strain on the wire connectors resulting from sudden tugs on the cord. This clamp fastens tightly by screw pressure on a tapered rubber bushing in the form of a sleeve... effectively sealing the cord entrance. Three pressure-type solderless lugs on the load end of the "ECC" allow quick connections to be made with Type S Rubber-Covered Cord in ranges of #18 to #12, AWG. The grounding connector is plainly identified with a letter "G" on the block. Only the APPLETON Type "ECC" Explosion-Proof, Dust-Tight Cable Connector offers so many worthwhile features for such an economical price.

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"ST" Series Connectors

Outlet Boxes

Malleable Iron Unilet Fittings

Reelites

Bending the "big inch" near Conroe, Texas. All pipe was yard coated.

Crew welding joints near Conroe.

was made in order to minimize the number of trees destroyed through the Sam Houston National Forest Park in Montgomery and Walker counties. Stemming in part from Sinclair's national program promoting national parks and landmarks, this plan also had the advantage of sharing the cost of maintaining the right-of-way through this heavily wooded section of Texas, sharing the cost of cathodic protection, and providing an opportunity to stagger aerial patrol to acquire closer spaced line coverage.

In the Houston area, it was necessary to parallel other companies' pipelines in order to procure economically necessary right-of-way through the congested area. Where the line traversed sub-divisions and industrial properties, it was deemed prudent to purchase several fee right-of-way tracts, to form a pipeline corridor with use running exclusively to Sinclair and to provide adequate future working space.

Continuing expansion of sub-divisions, roads, and streets in Harris County made it desirable from a future savings standpoint to encase all existing roads, hence Sinclair made the decision that the pipeline was to be double coated and double wrapped and buried with a minimum cover of approximately five feet from the Houston Ship Channel through Harris County.

Examination of other pipeline installations through Harris County in creeks and ditches, controlled by the Harris County Flood Control, revealed that due to annual ditch cleanouts, all or most of these pipelines were exposed in the bottom of the ditches and creeks. This resulted in the decision to span all such water courses by arching the pipe, thus eliminating the hazard of possible damage by equipment when cleaning out the ditches.

Sinclair management authorized construction of the Teague to Houston section of the line in December 1957. Golightly Construction Corporation of Houston, Texas, was awarded the contract to build a 6-mile section north from the Houston Ship Channel. This was called the "Downtown plumbing" job, as it was laid in densely built up areas. The balance of the 150-mile job was awarded to Lone Star Pipe Line Constructors, Inc., Dallas, Texas.

In the 6-mile segment, the pipeline closely parallels numerous lines of other companies, and traverses subdivisions and a golf course. It also crosses Greens Bayou, which is equivalent to a major river crossing.

The entire 150 miles of 20-in. pipe was yard coated with coal tar enamel; no over-the-trench coating methods were used.

Yard Coated Exclusively

This project was Sinclair's first experience in big diameter pipe laying for long distances where yard coating was used exclusively. The pipe was grit blasted prior to coating, resulting in an excellent coating job due to the nearly perfect bond between coating and pipe.

Prior to beginning construction, the district offices of the Texas Highway Department at Bryan and Houston, as well as the Harris County engineer's office, were contacted to ascertain the location of any existing county or state controlled roads proposed to be widened, or any new roads in the path of the pipeline scheduled for construction in the next five years.

As the job progressed, constant contact was kept with both county and state agencies to learn any new developments that might necessitate alterations in the 20-in. line after its installation. It is estimated that many thousands of dollars were saved for the public by this close cooperation on the part of Sinclair in, for instance, installing the line in known future road rights-of-way where no roads nor road rights-of-way now exist. This will avoid changes when the proposed roads are built.

As another example, it was necessary to do away with a planned over-bend near Greens Bayou in Harris County and lay the line on a uniform grade in order to allow the installation of casing at a later date without cutting the 20-in. line. This was at a point where the pipeline intersects proposed U. S. Highway 90 from Beaumont to Houston, which is scheduled for construction about 1968.

The line also intersects the proposed Interstate Highway 75 between Houston and Dallas at three locations. On the first crossing out of Houston near Spring Creek, the line was installed through a continuous 800-ft section of 24-in. casing. Installation of casing for the other two crossings was not possible due to the fact that the Texas Highway Department was unable to provide grade information or actual right-of-way location as their planning was merely in the preliminary stage.

Construction began on the second week of January 1958. During the months of January and February continuous rain hampered construction to a great extent.

The six-mile segment, north from Houston Ship Channel, was completed on April 1, exclusive of clean up. The clean up was delayed for several months due to deep penetration of moisture into the soil.

In addition to wet weather problems in January and February, another challenge was encountered at the Missouri Pacific Railroad crossing near Spring, Texas, and at the Spring Creek crossing near Houston where it was necessary to set well points and remove water

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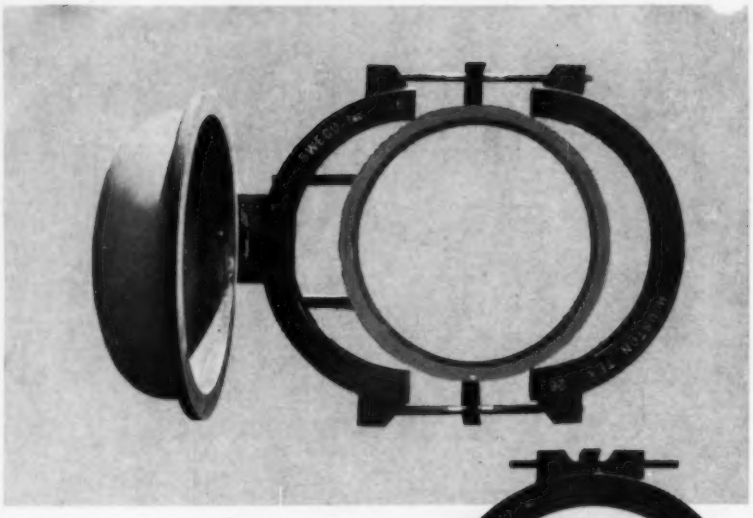

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For scraper traps, blowdowns, meter runs, vessels, tanks, strainers, filters, heat exchangers, where blind flanges or manways are required.

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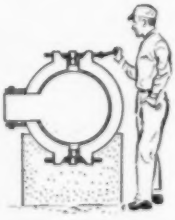

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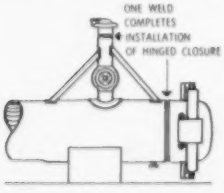

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The Author

J. R. Ligon *received a BS degree in mechanical engineering from the University of Texas in 1937 and was immediately employed by the Sinclair Pipe Line Company as district engineer at Mexia, Texas. He was promoted to division engineer and transferred to the division office in Fort Worth July 1, 1941. On September 15, 1945, he became assistant division superintendent at Fort Worth, the title being changed to assistant division manager on January 1, 1954. He was promoted to assistant chief general engineer, Independence, Kansas, July 1, 1957, but remained in Texas on special assignment as project manager on the work discussed in this article.*

Ligon is a Registered Professional Engineer and a Registered Public Surveyor in the state of Texas, and a member of the Texas Society of Professional Engineers and the Fort Worth Petroleum Club.

from the quicksand in order to prevent the pipeline ditch from caving.

After the contractor had completed the pipe laying in the congested Harris County area where the line had five feet of earth cover, progress continued at an average of 1½ miles per day to the completion of the job on July 11, exclusive of clean up.

The pipeline as completed consists of 21 miles of 0.312-in. wall, 20-in. OD, grade 5 LX-52, south from Teague and 118 miles of 0.281-in. wall, 20-in. OD, grade 5LX-52 and 11 miles of 0.312-in. wall, 20-in. OD, grade 5LX-52 on the south section of the line at the Houston Ship Channel.

The line was coated for the 34½ miles in Harris County with two coats of coal tar enamel, glass fiber and felt wrapper. The balance of the line was coated with one coat of coal tar enamel, glass fiber, and Kraft paper wrapper.

Thirteen valves were installed in the line at strategic points on approximate 10-mile spacing.

The third phase of this project, the replacement of the diesel station with an electric station at Jacksboro, Texas, was begun on July 1, and the fourth phase, the replacement of the station at Teague, is projected to start in September of this year.

It is anticipated that by January 1959, the total four-phase project will have reached completion. ★ ★ ★

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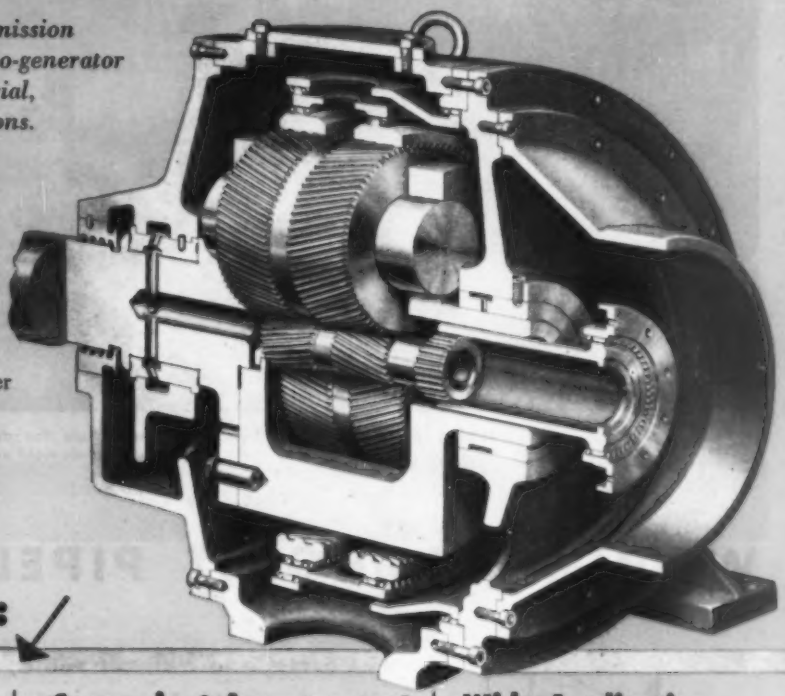

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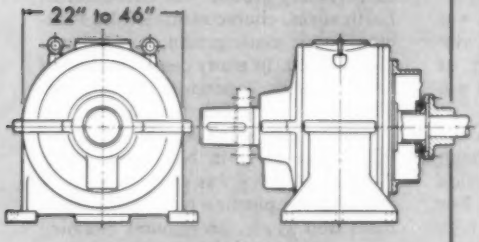

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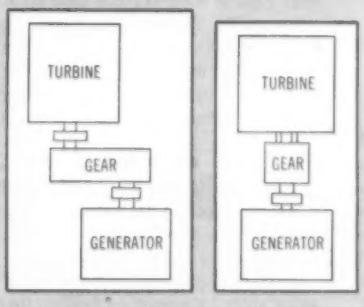
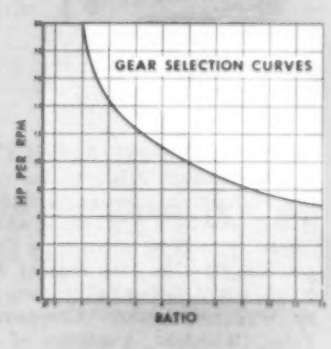


Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

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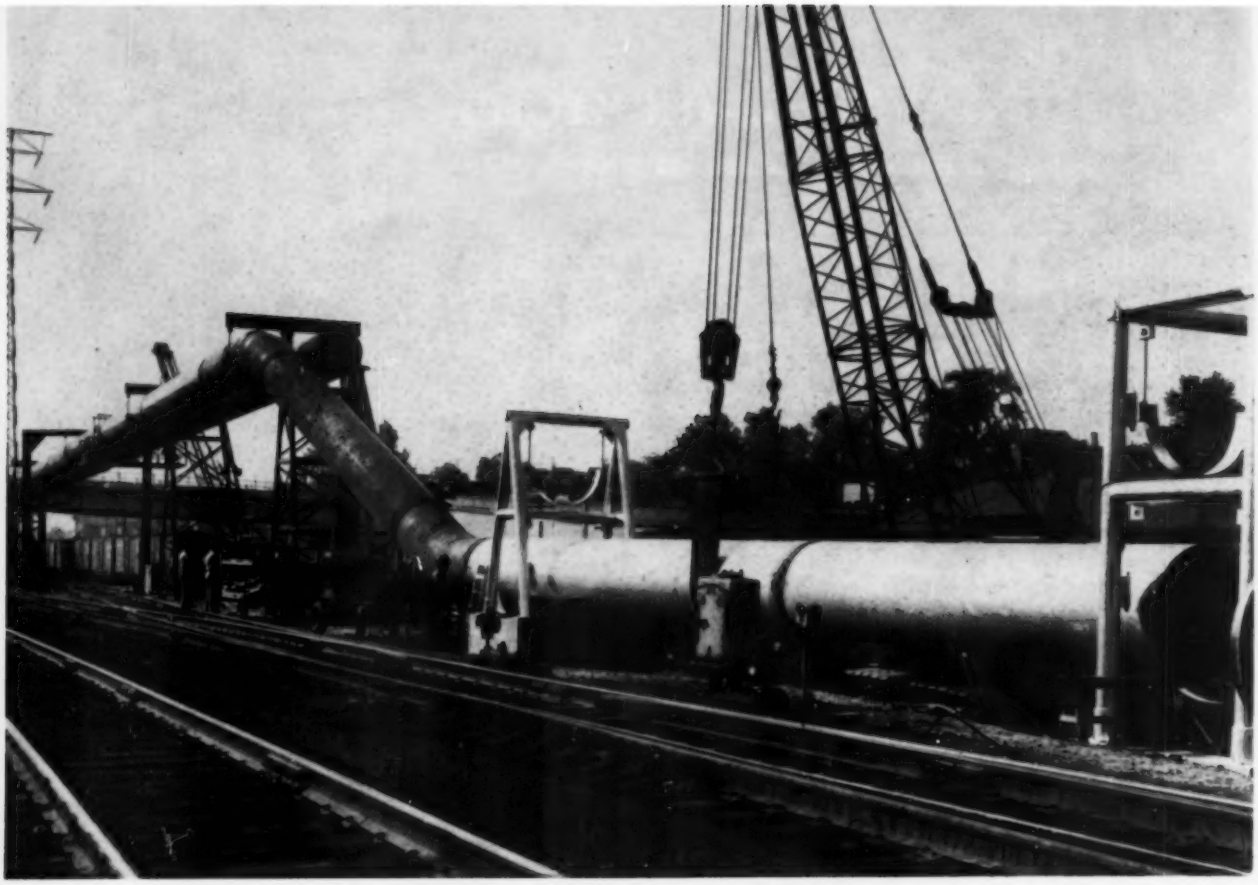

Laying above-ground 55⅜-in. diam pipe. Note the different types of tower construction, the belt slings, and on the extreme right an expansion joint.

P 623.

WORLD'S LARGEST PIPELINE- 55 IN.

Fred Brady,
Project Engineer
Williams Brothers Company

Varied and difficult route, as well as pipe size, made unusual construction methods necessary

NOW UNDER CONSTRUCTION near Pittsburgh, Pennsylvania, are a pair of the world's largest diameter gas transmission lines. The system, which is owned and will be operated by Carnegie Natural Gas Company of Pittsburgh, was designed and is being built by Williams Brothers Company of Tulsa, Oklahoma. A mixture of coke oven gas and stabilized natural gas will be distributed to six U. S. Steel Corporation mills along the Monongahela River.

The 12½ miles of parallel line consists of 16 miles of 55⅜-in. pipe and 9 miles of 43¼-in. pipe. Smaller diameter pipe is used for the laterals to the using mills. The line will have a capacity of 225,000,000 cu ft a day and was designed to operate at 50 psi. The system will initially operate, however, at a lower pressure of from 10 to 12 psi.

All Types of Construction

Because of the varied and difficult route, all types of pipeline construction were required to lay the twin lines. For example, the pipe was placed on high towers, in open ditches, on steep hillsides, over a suspension bridge, through tunnels, and on cantilever supports built 50 ft above the Monongahela River. Approximately 60 percent of the line was erected on supports above ground and 40 percent was buried.

Existing structures and facilities hampered the movement of equipment and materials through plants and populated areas. Outside the plants, extremely hilly ground was encountered. Earth slides, characteristic of the Pittsburgh area, made grading and excavation difficult. In many cases, reinforced concrete walls, concrete cribs, and piles were used to stabilize the hillsides.

Preliminary planning and construction began early in November 1957. A control survey was started to firmly establish the pipeline route as to alignment and grade. Horizontal chaining was used throughout the system, and bench marks were established at convenient locations.

Pipe Pieces Numbered

Inasmuch as the pipeline had to be laid to an exact alignment and grade,

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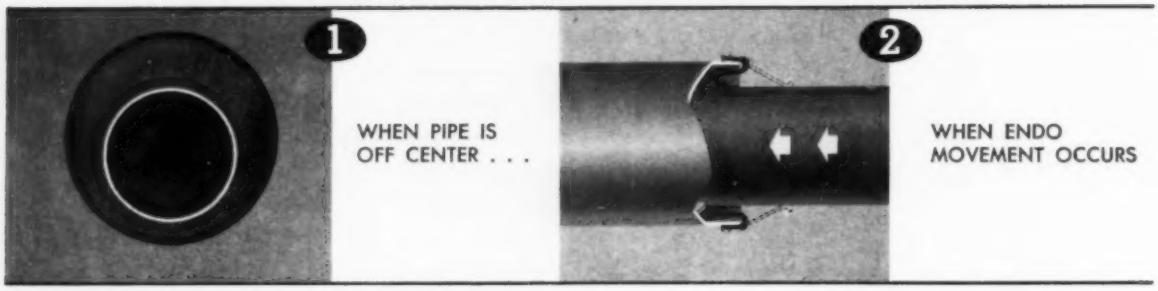

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WHEN ENDO MOVEMENT OCCURS

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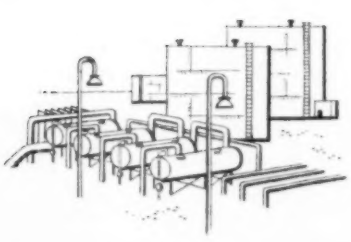

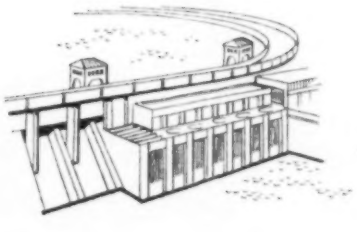

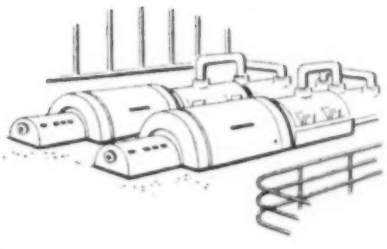

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for extreme efficiency
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70,000 horsepower of remote controlled LSV-16 turbo-charged gas engines, driving Cooper-Bessemer RFB-24 centrifugal boosters on Gulf Interstate's pipeline. These are the world's most efficient compressor units and are operating in five separate unattended stations.

Based on the successful operating record and outstanding fuel economy of the initial one unit installation at Stanton, Ky., Gulf Interstate increased this station to four engine-driven centrifugals and powered new stations at Hartsville, Tenn., Inverness, Miss., Corinth, Miss., and Alexandria, La., with four high-efficiency Cooper-Bessemer units each.

For detailed information on advantages and applications of automatic pipeline control, write The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

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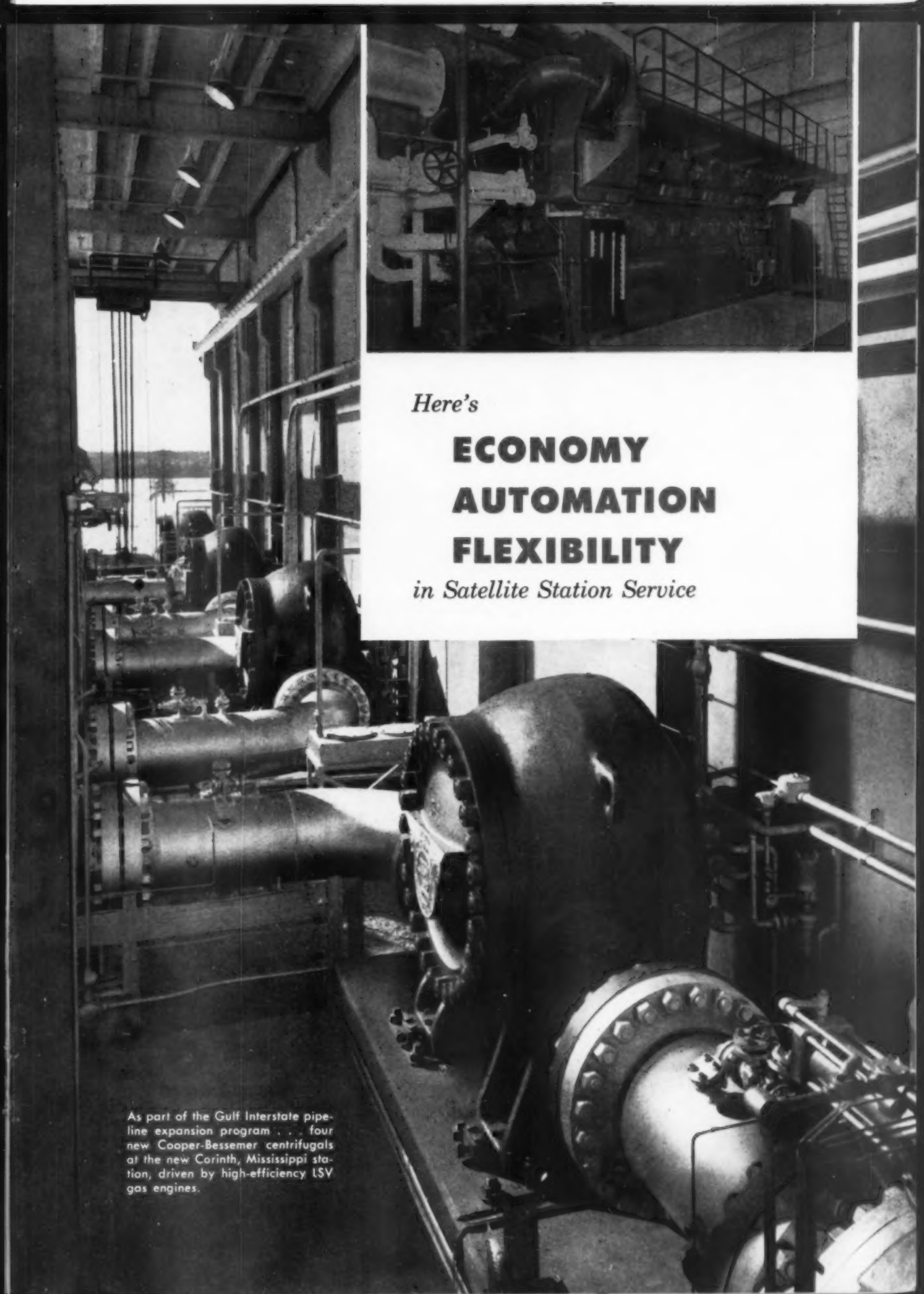

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ECONOMY AUTOMATION FLEXIBILITY

in Satellite Station Service

As part of the Gulf Interstate pipeline expansion program . . . four new Cooper-Bessemer centrifugals at the new Corinth, Mississippi station, driven by high-efficiency LSV gas engines.

A double road crossing, a cased railroad crossing, and pipe tower supports are shown here. The nearest sections of pipe are double coated and wrapped and will be backfilled after pouring of a concrete anchor.

the pipe was designed and fabricated so that each of the 4200 pieces of pipe was numbered and had its exact position in the pipeline. By having each piece of pipe cut to exact dimensions, the construction crews had only to lay the pipe, and did not have to spend time fabricating pipe in the field.

Fabrication of the pipe began at the Ambridge Plant of the American Bridge Company in February 1958. Standard straight sections were 40-ft long and were fabricated from two plates, rolled into a half-cylinder and joined longitudinally by automatic welding. Special straight lengths and single and multiple bend miters were then fabricated from standard sections.

A fabrication tolerance of ½ in., plus or minus, was specified for out-of-roundness of the pipe. In addition, miter bends were checked in a special jig to insure that the ends were square, to within ⅛ in., with the centerline of the miter.

Since many sections of the line are welded, close tolerances in laying and erection were required to maintain a small uniform welding gap between joints. To this end, the control survey, the fabrication of pipe, and the calculation of grade was made to permit the variation in spacing to be less than ⅛ in. when the "fit-up" was made in the field.

For the end of each straight run of pipe, an allowance of ¾ in. per 100 ft was added to the last joint of pipe for trim.

After acceptance at the fabrication shop, either bitumastic 300 paint, red lead and aluminum paint, or underground coating was applied to each piece of pipe to within 12 in. of the end.

The pipe was then transported to the storage yards located along the Monongahela River near Dravosburg, Pennsylvania, at about the mid-point along the line. Twelve acres were required to stockpile enough pipe to assure a plentiful supply during construction.

Many access roads were constructed outside the plant areas. These roads were used for construction and are to be maintained to permit continued access to the pipeline. The roads on steep hillsides required special consideration. Concrete cribbing was used to widen the roads and hold back the soil where severe cuts were made. Distribution of excavated material was carefully made to prevent excessive amounts of overburden from causing earth slides.

Foundations for the structural steel towers were started in December after the control survey had been completed. Excavation for these foundations disclosed many existing pipelines, old foundations, and some extremely poor bearing material. For these reasons, final design of many foundations occurred on the jobsite.

Special methods were necessary for foundation construction on hillsides. In some cases the concrete was chuted long distances to the site. In slide areas, piling was driven to rock and tied to the foundations to prevent lateral movement and settlement. All concrete was slump tested and test cylinders were made for observation of 7-day and 28-day strength.

Suspended Over River Bank

A section of the pipeline was suspended over the south bank of the Monongahela River on cantilever supports. These supports were made from steel wide flange sections. A portion of each support extended back under heavily traveled railroad tracks. Because of the rail traffic, the use of concrete for anchors and front pads in this area was impossible, therefore, 8-in. steel pipe sections were driven 80 ft into the bank in place of the concrete. Hand excavation was required to install the support. After installation, gunite was applied to reshape the bank.

Smaller structural steel and pipe towers were completely fabricated at shop and trucked to the jobsite. Erection consisted of setting the towers on the foundations and grouting them to grade. Larger towers, up to 35 ft were transported to the jobsite in halves and the same erection procedure followed.

Bridge Over Railroad Yard

A 360-ft suspension bridge with 175-ft approaches was erected over the Monongahela Junction railroad repair

yards. The support of the twin 43 ½-in. pipe makes this one of the largest diameter pipe suspension bridge in the world. Anchors required 474 cu yd of concrete. The two main cables were composed of 2¾-in. bridge strand. After the anchors were poured, erection of the steel work was completed in a two week period.

A total of eight underground cased crossings were made, the longest of these being 247 ft for each line. As the casing was 62 in. and 55⅜ in. conventional boring methods could not be used. Therefore the opening was hand excavated and the casing pipe jacked through as the excavation proceeded. Standard boring methods were employed on the smaller diameter pipe used for laterals.

As the preliminary construction progressed on the above-ground sections, a concrete and steel framework was completed ready to receive the pipe. In the buried sections the right-of-way was cleared and ready for excavation. For both sections, the access roads, used both to lay the pipe and to carry equipment and materials to the jobsite, were completed. This permitted the laying crews to proceed at a rapid pace in the actual construction of the pipeline.

Since the working areas was restricted and interruptions to normal progress were caused at many points along the pipeline route, many small crews were employed to lay the lines. Location of these crews was governed by the pipe delivery schedule. As stated previously, each piece of pipe was numbered and had an exact location in the line. The dispatching of the various pieces of pipe in the proper sequence from the fabrication yard to each crew, required advance planning of each days work and coordination by radio to each worksite.

Big Cranes for Laying

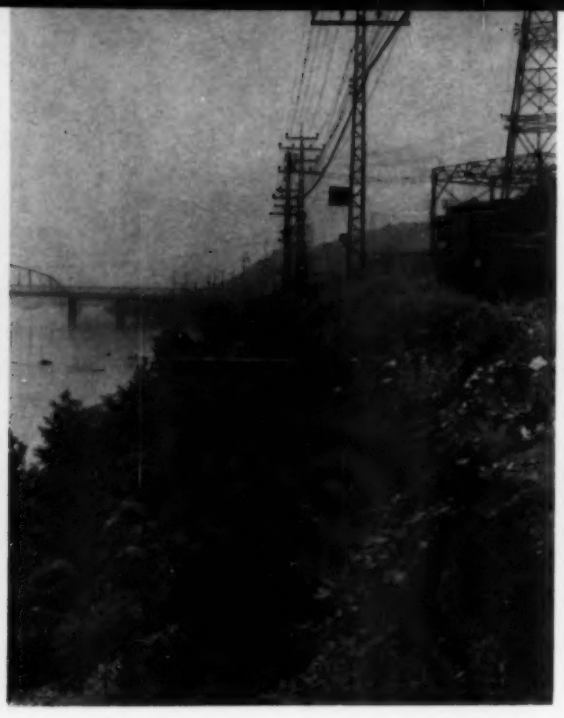
Forty and 50-ton cranes were used to lay the above-ground pipe. Obstructions to laying and the height of the pipe required boom lengths of up to 100 ft. Special slings were required to prevent damage to the pipe in handling. Since the tower spacing was usually less than 80 ft, two pieces of pipe were double-jointed on the ground and then lifted into position. Experience proved that the best fit-up occurred when the largest section that could be conveniently handled was fabricated on the ground and then lifted into place.

Angle of rotation was marked on the end of each single and multiple bend miter. This angle was accurate to the nearest 1/16 in. Constant field checking of alignment and grade eliminated the need for extra trim sections.

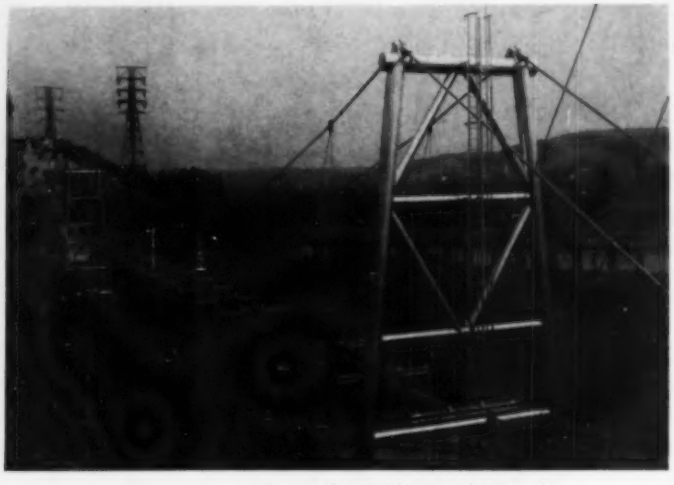
Hydraulic internal and external clamps held the ends of the pipe in

Construction of a metering station.

Laying of buried pipe.



Cantilever supports along the Monongahela River — pipe will be laid from the river side so as not to interfere with railroad traffic.



Suspension bridge ready for pipe.

place for fitting and welding. The internal clamp was pulled from joint to joint through the inside of the pipe with a cable line. This clamp was designed to pass through single and multiple bend miters. The external clamp was drawn tightly around the pipe with a hydraulic jack. Steel wedges were then driven into slots in the clamp to complete the line-up. Depending on the situation, either the internal clamp or the external clamp, or on a combination of both, was used at each joint.

Welding Time — 8 Hr Per Joint

After the line-up, two welders working four hours each were required to complete one weld on the 55⅜-in. pipe.

Expansion joints were welded in the above-ground line at intervals of approximately 600 ft. They were received in the field with the slip side pipe already inserted in the expansion joint. This permitted the laying crews to set the correct adjustment, up to 10 in., for the particular location and weld them into the line as they would any other piece of pipe.

One-half of one percent of the total area of the pipe had to be repainted after construction was completed. Areas to be painted were sandblasted to insure a good bond between the metal and paint. These unprotected areas occured at welded joints and at places where the coating had been damaged by handling.

Ditch Made With Backhoes

Excavation for the buried pipe was usually made with two-yard backhoes. On steep hillsides, however, smaller machines were employed and anchored to winch tractors for stability. The ditch was of such size that one line was laid and backfilled before the other parallel line could be laid in the limited space.

A small crane was used to unload the pipe from the trucks. The pipe was then double-jointed to lengths of 80 ft and laid in the ditch with sideboom tractors. In one case, a section of pipe 140 ft long was placed on a steep hillside with two sideboom tractors.

The use of Dresser type couplings on some sections of the buried line allowed larger working tolerances for alignment and grade. At fabricated bends, however, the alignment and grade had to be corrected to allow them to be welded in the line. To prevent blowout of the couplings at bends, concrete anchor blocks were poured around the pipe after it was in place.

Coating and wrapping of the unprotected areas on the buried pipe was done immediately to facilitate backfilling.

Supplemental Installations

Construction of supplemental installations required for all pipeline systems started after the main line was finished. Some of these included: Connecting drip tanks to the main line; connecting laterals to tie in the using mills; erection of operating platforms and buildings; installation of the electric wiring and the telemetering system required for the automatic operation of the pipeline; construction of meter runs, and construction of a system to stabilize natural gas.

Upon completion of construction, approximately 16,000 tons of pipe will have been laid; nearly 900 tons of steel erected for supporting structures; 5500 cu yd of concrete placed for anchors and foundations; 1700 lineal ft of 62-in. casing jacked into place; five permanent buildings erected, and many miles of cable and wire installed for telemetering and electrical wiring.

Production methods of construction were made possible, even for these large diameter lines and varied conditions, by planning the work in advance and by using experienced, qualified personnel together with the proper size and type of equipment.

Experience gained from the design and construction of this pipeline has proved that if increased capacity is required, there are no insurmountable problems encountered in the building of a large diameter pipeline system. ★

Fred H. Brady, project engineer for Williams Brothers Company on the design and construction of the pipeline discussed in this article, holds a BS degree in civil engineering from the University of Arkansas. Prior to joining Williams Brothers he had his own engineering and contracting firm. He has also held engineering positions in the pipeline industry, plant construction industry, and with the United States Government.

HOW TO BUILD BETTER PIPELINES FOR LESS

Peter Flagg, *President*
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The key is proper reporting of work progress from field to headquarters, and this is accomplished by a formula called Man-Hour-Factor Design

A PIPELINE CONSTRUCTION firm is like an army on the move. Efficient completion of a project depends upon the skillful deployment of men and machines.

At C. N. Flagg and Company, Inc., where our operations encompass many states, we believe the key to building better pipelines for less lies in proper methods of reporting work progress from the field to headquarters. This means much more than keeping open the channels of communications. It means daily and weekly analyses to determine if production is on schedule — and if it isn't, why.

Man-Hour Factor Design

In order to accomplish this, we have developed what we call a Man-Hour Factor Design, a formula that allows us to compare our estimated with our actual work progress picture. This formula helps us pin-point trouble spots and it guides us in our overall bidding practices in an area.

The Man-Hour Factor is derived by dividing production (in terms of feet of pipe installed) by the number of men on a crew. Man-hours are obtained by multiplying the number of men on such a crew by the number of hours per day the crew works. In taking into account the entire crew and its equipment, experience has taught us that 10 hr per day is an accurate working figure. For example, on a job in which we were to install 100,000 ft of 6-in. pipe, we might require four crews of 15 men, each crew to lay 750 ft per day. Our man-hours per crew is equal to 150 (15 men multiplied by 10 hr per day). We then compute our MHF to be 5.0 (750 divided by 150).

After encountering normal operational difficulties, we might find at the end of the first week that our actual MHF averaged 3.0. By the end of the second week, our MHF Weekly might climb to 4.8, giving us an MHF Accumulative average for the two weeks of 3.9. At the end of the third week, our MHF Weekly might jump to 6.5, raising our MHF Accumulative to 4.8.

Our report card for the first three weeks would look like this:

	MHF Design	MHF Weekly	MHF Accumulative
1st Week	5.0	3.0	3.0
2nd Week	5.0	4.8	3.9
3rd Week	5.0	6.5	4.8

Any interruptions in this normal upward climb during the early weeks, or a sudden decline in later weeks, would immediately precipitate an investigation to determine the origin of difficulty. For instance, in a recent job in South Carolina we encountered a high water table in a special type of gumbo mud. Our daily man-hours factor indicated more time was being spent in coping with this situation that was originally planned.

An immediate check revealed additional equipment was required on this site and it was immediately transported from New York State. Certainly, in time, we would have brought the equipment in anyhow, but thanks to a sound method of reporting we were able to check the downswing and bring our MHF Accumulative into line with our MHF Design within a short period of time.

Once the MHF Accumulative reached 5.0 in the above example, and is kept there, the work is proceeding on schedule and the time deficit has been made up.

How Reports are Handled

Daily MHF reports are computed at the work scene by our foremen. These are analyzed by our area managers in headquarters in Lockport, Auburn and Albany, New York; Charlotte and Wilmington, North Carolina, and Hartsville, South Carolina. Weekly MHF reports are forwarded to our home office in Meriden, Connecticut, by area managers for inspection by top-level supervisors. This basic communication system has proved to be an effective, cost-saving method of controlling operational expenditures.

Naturally, the MHF Design is only as good as the organization that backs it up. It is a tool that requires high caliber personnel, active top level supervision, and quality, modern equipment on standby call if it is to be utilized properly.

Proper maintenance of modern equipment is extremely important. We follow the simple rule that the book value of equipment should not exceed more than 10 percent of our annual sales volume.

Keeping Investment Down

In order to keep equipment investment down, mobility is required. Movement of equipment must be coordinated between areas and within areas. For inter-area movements, we have an equipment pool and keep low-beds on reserve. Consequently, when we needed that additional equipment in South Carolina, it was available and a low-bed on which to transport it was on reserve.

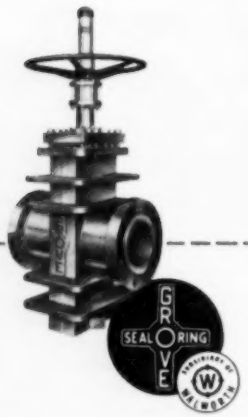
We follow a strict policy of buying equipment on quality and not on price alone. Money is lost in buying equipment that has not been designed for the purpose for which it must be used. This does not mean savings should not be made whenever possible. In anticipation of the growth of the pipeline industry, and our own expansion, we have been purchasing equipment at great savings during the past eight months.

Goal: Permanent Workers

In the final analysis, the human element is paramount. Personnel policies are a major consideration for any company, but the problems affecting the pipeline construction business are unique. In an attempt to overcome the transient employee situation prevalent in the industry, we are endeavoring to build an organization of permanent year-round workers who will remain loyal to our firm. Because of this, we exercise extreme selectivity in the choice of personnel.

To reduce turnover, particularly at

.....wipe out the need for lubrication



Lubrication problems are wiped out with the squeegee action of the exclusive Grove Seal-O-Rings. Up or down movement of the gate through the floating seats cleans and polishes both upstream and downstream surfaces. Foreign matter which could cause sticking, distortion, or abrasion is removed. The "O" Rings provide smooth action through the seats and bubble tight pressure seals on both sides of the gate. Specify Grove Seal-O-Ring Gate Valves. When they're set you can forget about lubrication or sealing compounds forever.

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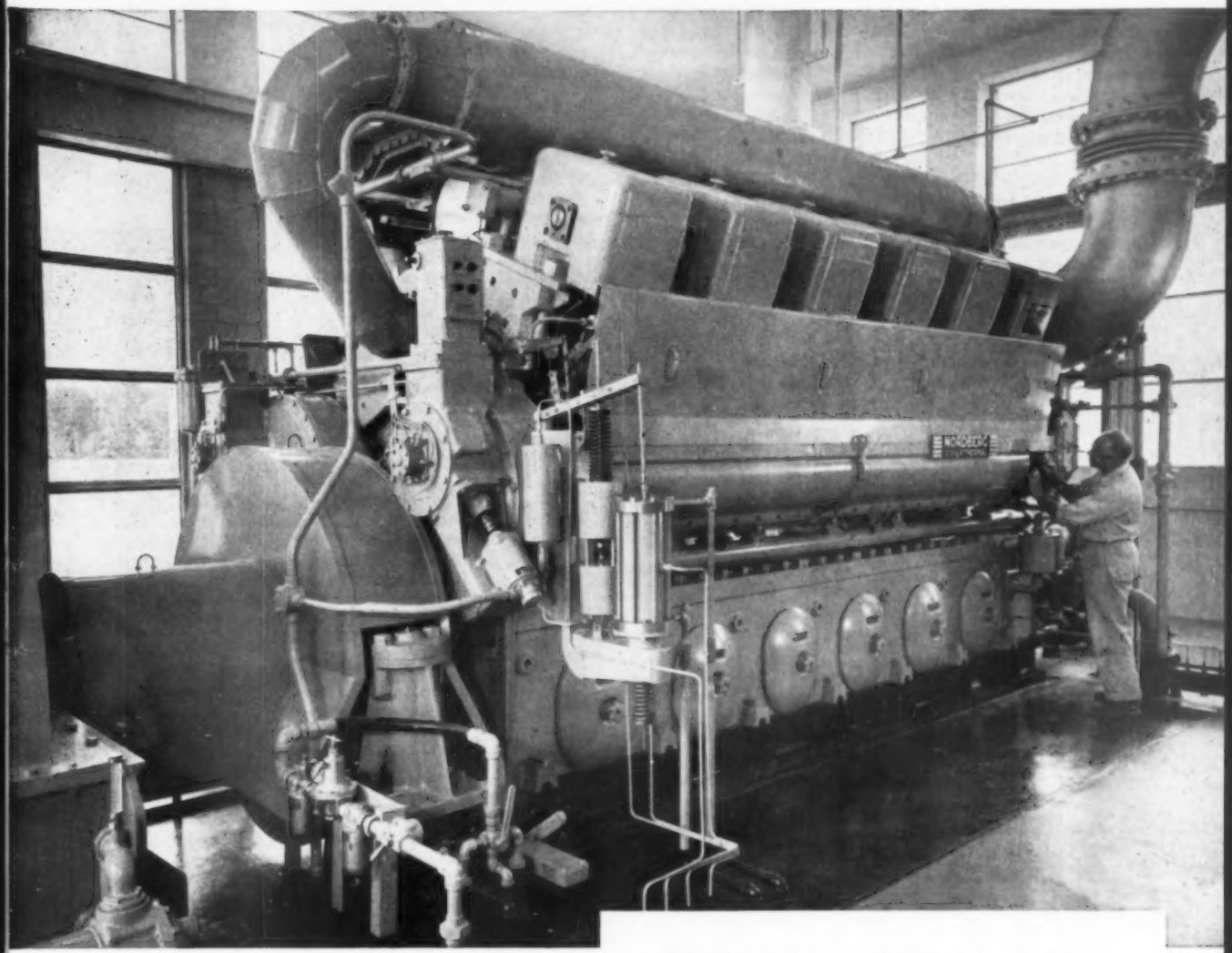

Wolverine Pipe Line Co.

This compact, automatically-controlled Nordberg *Supairthermal®* V-type Diesel engine furnishes all power for the Vicksburg, Michigan station of the Wolverine Pipe Line Company.

Driving a centrifugal pump rated 3220 gpm through a 10.189 to 1 speed increasing gear and flexible coupling, this 2650 bhp Nordberg four-cycle engine is an important unit in the modern Wolverine 16-inch products system.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

FREE PIPE LINE BROCHURE

New easy-to-read picture story of Nordberg engines on crude, products and gas pipe lines. Send for your free copy now.

NORDBERG

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the foreman level, we have introduced a bonus-incentive and profit-sharing pension plant for all salaried employees. These items represent an investment in our workers, but in the long run they pay off. Experience shows it is more expensive to train men in your own way of doing things and then lose them to a competitor.

Pecuniary rewards are not the only way of inducing loyalty. Equipment and safety meetings, conducted at least once a month in each area, can convince an employee of your interest in him — and save untold dollars in accident prevention. When an accident occurs, we go over its causes with our workers in an attempt to explain how it happened and to prevent its recurrence.

Public Relations Policy

Sound employee relations are important in developing a sense of responsibility to the community in which pipelines are being laid. A pipeline installation firm must imbue its workers with its public relations policy. Nothing is more important than the way in which a pipeline installation firm is accepted in a community and nothing can destroy that delicate relationship faster than an injudicious act on the part of an employee.

Peter Flagg, *34-year-old president of C. N. Flagg and Company, is a great believer in taking to the air to transport staff supervisors to the scene of widespread operations. Here the former air force bomber pilot sits at the controls of his company's seven passenger Aero Commander. He pilots the aircraft most of the time with a co-pilot.*

"Clients are impressed by the way the plane increases our efficiency and speed," he says.

In 1949, at the age of 26, Flagg took over his father's business in Meriden, Connecticut, and built a local plumbing and heat contracting firm into a national pipeline construction company that will gross $10,000,000 in 1958.

We take great pains to tell the general citizenry, through newspaper ads, publicity, and special brochures designed as part of an overall public relations program, exactly how we will proceed to lay pipelines and how we will care for their property. As a result, we not only generate good will, but we receive cooperation of governing authorities which, in turn, helps us maintain a rigid schedule.

The analysis of our MHF Design and the coordination of our men and machines, requires alert, top-level supervision. This means our managers, including the president, must be ready to move on a moment's notice to trouble spots for inspections or staff meetings.

We have found that the best, fastest, and safest method of transportation to out-of-the-way places is by company plane. Our seven passenger Aero Commander is continually on the go. It is handled by two pilots and equipped for all-weather flying. It is not uncommon for a staff member to have breakfast in Connecticut, lunch in western New York State, and supper in the Carolinas. It is far and away the best method of keeping up-to-date and currently informed.

It is up to the top-level supervisors to make sure that all the ingredients are integrated. When they are, everybody gains. ★ ★ ★

★ ★ ★ ★ MAXIM ANNOUNCES NEW LINE OF LOW COST AIR-JACKETED SILENCERS

Now it is more financially practical than ever before to ventilate as well as silence engine rooms. Maxim research has reduced the cost — while improving the efficiency — of air-jacketed silencers.

Maxim Air-Jacketed Silencers offer you a low cost "package" that combines noise suppression and ventilation . . . that avoids accidental burnings . . . that lasts years longer than conventional silencers and with less maintenance.

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NEWS

GE to Move Communications Operations to Lynchburg, Virginia

General Electric Company has announced plans to consolidate its mushrooming communications business in an existing company plant in Lynchburg, Virginia.

All operations of the firm's Communication Products Department, now located in four New York state cities, will be moved to a facility in Lynchburg, which was built in 1956 for production of rectifier equipments and components. The manufacture of rectifier equipments will be transferred to an existing General Electric location in Philadelphia.

The Communication Products Department, which makes two-way radio and point-to-point communication equipment, now has headquarters offices in Liverpool, New York, and manufacturing facilities in Syracuse, Utica, and Clyde.

A definite time-table has not been established but the company announced that the moves would begin as soon as detailed planning is completed. They will take place gradually over a period of several months.

Little Big Inch Preparing for Heavy Shipments LP Gas

Texas Eastern Transmission Corporation will give top priority to plans to extend its LPG pipeline transportation system to the Eastern Seaboard to serve Mid-Atlantic and New England states, according to Millard K. Neptune, senior vice president of the company. The decision to accelerate was made, Neptune said, after completion of a successful shipment of propane from the Gulf Coast to Lebanon, Ohio, which proved the ability of the line to handle liquefied petroleum gas satisfactorily.

Texas Eastern also has begun construction of a fractionating plant that will process LPG sent to the Lebanon area before it is released to customers to assure delivery of a pure product, Neptune said. "This plant is being erected on the site of Texas Eastern's new LPG underground storage cavern now under construction about 15 miles southwest of Lebanon and approximately 30 miles north of Cincinnati. This storage facility will be known as the Todhunter Terminal. The fractionating plant is expected to be completed and ready for operation by December 1."

Pipe Line Technologists Now Working in a "Glass House"

Since occupying their new $350,000.00 home office building in Houston, Texas, Pipe Line Technologists, Inc., is literally working in a "glass house."

Three walls of this new two-story structure, which is 43 ft by 143 ft, are entirely of glass, extending from first floor sills to the second floor ceiling. The fourth wall is insulated steel paneling. The east and west walls, 143 ft in length, are shaded by a free-standing solar screen, four feet from the glass walls of the building.

Use of the solar screen on the Pipe Line Technologists building is one of the first applications on an office building in Houston. It has been used extensively in South America for the past several years. The "screen" not only makes practical the use of glass walls for increased lighting as well as beauty, but helps to increase the efficiency of air conditioning. It shades the walls, to eliminate the heat load normally set up by direct sun rays. In addition, the flow of air through the multiple openings in the screen sets up a convection circulation action in the four-foot space between the building, to further cool the building and substantially decrease the heat load to be overcome by the air conditioning system.

STAYS ON THE LOWERING—IN GANG'S HEELS

The Cleveland 190—*with just one man*—keeps your backfill operation "up close" on all kinds of pipeline jobs. He's got the *right* combination of line and travel speeds for continuous, high, day-long production on *every* backfill job—big ditch or small—dirt, sand, muck or rock—in swamps, on the flat or up in the hills. Operators like it. *You'll* like the way it lowers your backfill costs.

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● H. L. Gentry Construction Company, P. O.

News

Texas Eastern Authorized to Acquire Two Subsidiaries

The Federal Power Commission has granted Texas Eastern Transmission Corporation authority to acquire and operate the natural gas facilities of two wholly-owned subsidiaries—Texas Eastern Penn-Jersey Transmission Corporation, of Shreveport, and Wilcox Trend Gathering System, Inc., of Dallas, Texas.

Texas Eastern said the Wilcox and Penn-Jersey systems are now operated as integral parts of its system and that the merger will promote convenience and efficiency of operation and will lower operating costs, such as bookkeeping and regulatory expenses.

Microwave Link Installed On Sinclair's System in Ohio

An 81-mile microwave system installed by the Radio Corporation of America provides a key communications hookup along the Sinclair Pipe Line Company's main petroleum transmission route in Ohio, it is announced by Norman Caplan, manager, RCA Communications Products Department.

The RCA microwave system links Sinclair's eastern divisional headquarters at Marion, Ohio, with Toledo to the north.

From Marion the microwave system travels 15 miles north to Nevada, Ohio. From there the signal is relayed 27 miles to Fostoria, 20 miles to Bowling Green, and another 19 miles to Toledo.

Each of the microwave stations on the system is equipped with RCA "hot" stand-by equipment, turned on and ready to go into action if needed.

The system provides five main channels for voice communications, and supervisory control and telemetering. A sixth channel is used for monitoring the microwave system's performance.

The sixth, or service, channel was arranged to permit the system controller at the Marion headquarters to check a station at any time merely by dialing the station's code number and receiving an automatic coded status report.

Project to Provide More Gas to Midwest Cancelled

An agreement to further increase gas deliveries to the midwest area through the Beatrice project construction program has been cancelled by mutual agreement of Colorado Interstate Gas Company and the Natural Gas Pipeline Company of America.

Originally it was anticipated that final FPC authorization for the project would have been obtained in 1957, and facilities installed this year.

"In view of the delay in time schedule beyond the control of both companies, we have agreed that it would be to our mutual advantage that the Beatrice contract be cancelled," W. E. Mueller, president of Colorado Interstate, said.

Gas supplies that were going to be used by Colorado Interstate in the Beatrice project will now be available to the California market through an agreement just reached with El Paso Natural Gas Company. By terms of this agreement, 200,000,000 cu ft of gas a day will be delivered to El Paso Natural at a location near Salt Lake City, Utah, and that company will construct facilities to deliver it to the southern California border.

Mueller said that a new subsidiary company probably would be organized to build facilities necessary to transport the gas from Colorado Interstate's present supply areas for delivery to El Paso Natural.

Technical Papers to Feature NACE New Orleans Meeting

Approximately 24 technical papers will be presented in four symposia during the technical program at the New Orleans meeting of National Association of Corrosion Engineers, October 20-24. It will be the 12th annual meeting of the NACE South Central Region.

One symposium, on oil and gas production, will hold two sessions. Other symposia are on offshore corrosion, corrosion of pipelines, and corrosion in the refinery and chemical process industries.

In addition to hearing technical papers in symposia, corrosion engineers will discuss their problems in more than 20 technical committee meetings.

Heading the list of prominent guests will be L. L. Whiteneck, Plicoflex, Inc., Los Angeles, president of NACE, and Hugh P. Godard, Aluminum Laboratories, Ltd., Kingston, Ontario, vice president.

Louisiana Polytechnic to Hold Instrumentation Conference

The School of Engineering, Louisiana Polytechnic Institute, Ruston, Louisiana, will hold its Seventh Annual Instrumentation Conference on the campus November 6 and 7.

The following technical papers will be presented:

"Fundamentals of Instrumentation and Controls," Dr. Virgil Orr, Head, Department of Engineering Research, Louisiana Polytechnic Institute.

"Instrumentation for Continuous Digesters," R. F. Barber, The Foxboro Company, Foxboro, Massachusetts.

"Automatic Control and Instrumentation of a High Pressure, High Temperature Steam Generating Unit," Harold McMichael, Leeds & Northrup, Houston, Texas.

"Design and Application of Orifice Fittings and Meter Tubes," Ralph Clemons, Daniel Orifice Fitting Company, Houston, Texas.

Exhibits of new equipment will be displayed by leading manufacturers.

Transco Wins Top AGA Accident Prevention Award

Transcontinental Gas Pipe Line Corporation, Houston, Texas, is winner of the American Gas Association Safety Achievement Award given annually for the best employee accident prevention record in the natural gas transmission industry.

The award will be presented October 14 at the AGA convention in Atlantic City.

E. Clyde McGraw, Transco president, received the notice from J. Theodore Wolfe, chairman of the AGA Executive Safety Committee.

Wolfe said the award was won by Transco for having the lowest accident frequency rate in the U.S. among member transmission companies with 1500 or more employees.

Stanley Owens, Transco's Director of Safety, said that the Houston-based company had progressed from 22nd in 1952 to 11th in 1956. The first place came as a result of the 1957 record for accident prevention.

Trans-Ural Mountain Gas Line to Operate by Year's End

Russia expects to put its first major trans-Ural Mountain gas pipeline in operation before the end of this year.

The 186-mile link, now under construction, will run from the Shkapovo fields in Bashkiria, west of the Urals, to the large eastern slope iron and steel center of Magnitogorsk. It will also serve metal industry plants in the southern Ural cities of Sterlitamak, Ishimbaevo, and Salavat.

WITH THE PIPELINE CONTRACTORS

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **F. E. Shaw, Ltd., 530 S. Vidal Street, Sarnia, Ontario.** Has 40 miles of 6 to 10-in. line for *Dominion Natural Gas Company, Ltd.*, in the Brantford, St. Catharines, and St. Thomas districts. Has 67 miles of 6 to 20-in. transmission lines for *Union Gas Company*, Chatam, Ontario, to Dawn, London, St. Marys, Stratford, Kitchener and Guelph.

● **Macco Corporation, 14409 Paramount Blvd., Paramount, California.** Has 20 crews installing and replacing gas pipelines in Southern California area for *Southern California Gas Company* and *Southern Counties Gas Company*.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has contract on 7240 ft 30-in. Mississippi River crossing at Happy Jack, Louisiana, for *Tennessee Gas Transmission Company*.

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has contract for 51 miles of 10-in. and 6 miles of 6-in. for *Buckeye Pipe Line Company*. The 10-in. line is between Utica and Syracuse, New York; the 6-in. is near Auburn, New York.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston 2, Texas.** Has 100 miles of 24-in. from Hughesville, Pennsylvania, to the Delaware River for *Transcontinental Gas Pipe Line Corporation*. Also has 35 miles of 30-in. for the same company between the Delaware River and Princeton, New Jersey. Has 38 miles of 30-in. for *Humble Oil & Refining Company* between Clear Lake and Hankamer, Texas.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast. Has contract for 42 miles, 24-in. in Louisiana for *Southern Natural Gas Company*. Has contract to build segments of a *Natural Gas Pipeline Company of America* line from a point near Haddam, Kansas, to the Weeping Water, Nebraska area, a total of 106 miles and also 99 miles of the line from Mt. Etna to a point west of Knoxville, Iowa.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta.** Has 57 miles of 30-in. line for *Trans-Canada Pipe Lines*. Has contract for 80 miles of gathering lines for *Westcoast Transmission Company's* natural gas grid system in the Peace River region; plans call for laying some 20-in. as an extension to the main line and also smaller diameter lines down to 6-in. for the Blueberry field.

● **Western Pipe Line, Inc., 1011 San Jacinto, Austin 66, Texas.** Has 94 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Hawk Lake and Hyndeman, Ontario.

● **O. R. Burden Construction Corporation, Box 5216, Tulsa, Oklahoma.** Has 32.8 miles of 16-in. from Muncie, Indiana, to east of Hollansburg, Ohio, for *Panhandle Eastern Pipe Line Company*. Has 76 miles of 20-in. from Ft. Laramie, Wyoming, to Clendo Junction and from Casper to Welch for *Service Pipe Line Company*. Also has 54 miles of 12-in. to take up and recondition in Goshen, Platte, and Converse counties, Wyoming, for same company. Also has 29.5 miles of 8-in. to raise, recondition and replace between *Service's* Post and Cogdell stations in Garza and Kent counties, Texas. Has 47.7 miles of 12-in. from that company's Salt Creek station in Natrona County, Wyoming, to North Fork station in Johnson County and from Salt Creek to Casper stations. Has contract for gathering system consisting of approximately 84 miles of 4 to 16-in. pipe in Jack and Wise counties, Texas, for *Natural Gas Pipeline Company of America*.

● **Piggott Construction, Ltd, Calgary, Canada.** For *Interprovincial Pipe Line Company*, 82 miles of 24-in. loops in Alberta and Saskatchewan. For *Alberta Gas Trunk Line Company*, 145 miles of 24-in. from Pincher Creek field to Princess Junction, Alberta.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area of New Mexico and Colorado.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has 216 miles of 30-in. gas line loops for *Gulf Interstate Gas Company* in Louisiana, Mississippi, and Tennessee. Has 38 miles of 30-in. gas line for *Tennessee Gas Transmission Company* from the Gulf Coast to Yscloskey, southeast of New Orleans, Louisiana. Has Atchafalaya River crossing for *Transcontinental Gas Pipe Line Corporation* just north of Melville, Louisiana, consisting of one 30-in. and one 18-in. line. Has 54 miles of 24-in. natural gas line loops for *Gulf Interstate Gas Company* in the vicinity of Rayne, Louisiana. Has approximately 106 miles of 24-in. gas line for *Southern Natural Gas Company* in Mississippi and Alabama. Has 62 miles of 20-in. crude line for *Shell Pipe Line Corporation* from the vicinity of Nairn, Louisiana, north to Norco refinery above New Orleans.

● **Mannix Company, Ltd., 737 Eighth Avenue West, Calgary, Alberta.** Has 90 miles of 10-in. between North Bay and Sudbury, Ontario, for *Northern Ontario Natural Gas Company, Ltd.* Also has 220,000 ft of 2 to 8-in. distribution lines for same company in Sudbury. Has 20 miles of 2 to 14-in. for *British American Oil Company, Ltd.* consisting of a wet-gas condensate gathering system in the Pincher Creek, Alberta, area. Has 90 miles of 30-in. between Hearst and Kapuskasing, Ontario, for *Northern Ontario Pipe Line Crown Corporation*. Has 40 miles of 10-in. oil pipeline from Swan Hills field to Fort Assiniboine, Alberta for *Home Oil Company* and *McColl-Frontenac Oil Company*.

● **H. L. Gentry Construction Company, P. O. Drawer 32, Perrysburg, Ohio.** Has 40 miles of 24-in. between Oneida and Phoenix, New York, for *Niagara Mohawk Power Corporation*.

● **Vaughn & Taylor Construction Company, Inc., Box 3266, Odessa, Texas.** Has 22 miles of 2 to 20-in. waterflood system near Wickett, Texas, for *Gulf Oil Corporation*. Has 20 miles of 4 to 10-in. to take-up and relay on *Pan-American Petroleum Corporation's* gathering system in the South Fullerton field, Andrews County, Texas. Has 5 miles of 26-in. loop line near Panhandle, Texas, for *Cities Service Gas Company*.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has contract for 70.9 miles, 30-in., *Northern Ontario Pipe Line Crown Corp.*, between Beardmore to Longlac, Ontario. Has undetermined amount of gathering system for *Producers Pipeline Ltd.* in the Estavan, Saskatchewan, area. Has contract to lay city distribution system in Cooksville, Ontario, for *Consumer Gas Company*. Has city distribution system in Guelph, Ontario, for *Union Gas of Canada*. Has contract with *Trans-Canada Pipe Lines Ltd.* for 80 miles of 30-in. from Iroquois Falls to Kirkland Lake, Ontario.

● **Arey Pipe and Construction Company, Inc., Box 1501, Pampa, Texas.** Has 105 miles of 6-in. for *West Emerald Pipeline Corporation* between Amarillo, Texas, and Tucumcari, New Mexico.

● **Lone Star Pipe Line Constructors, Inc., 10301 Shady Trail, Dallas, Texas.** Has 143 miles of 20-in. crude line between Teague and Houston, Texas, for *Sinclair Pipe Line Company*.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 100 miles of 18-in. for *Alberta Gas Trunk Line Company, Ltd.*, from Burstall at the Alberta border to Provost, Alberta. Also has 22 miles of gas gathering line in the Provost field for *Provo Gas Producers, Ltd.*, consisting of constructing gathering system and wellhead tie-ins—3 to 12-in. pipe; this gas to be fed to *Alberta Gas Trunk Lines*. Has contract with *Saskatchewan Power Corporation* for 124 miles of 10-in. line from Steelman to Regina and 38 miles of 12-in. from main line's present terminus at Moose Jaw extending to Regina. Has 40 miles of 10 and 12-in. line for *Home Oil Company* and *McColl-Frontenac Oil Company* from Fort Assiniboine to Edmonton, Alberta.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Oklahoma Pipe Line Constructors, P. O. Box 13227, Dallas 20, Texas.** Has 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela; this is the company's first Venezuelan venture since 1944. Has 90 miles of 30-in. (known as Spread 14) for *Trans-Canada Pipe Lines, Ltd.*, from Toronto, Ontario, northward. Has 96 miles of 30-in. line from Columbus, Mississippi, to Tennessee River for *Tennessee Gas Transmission Company*. (This project to be performed by Oklahoma Contracting Company.)

Pipelines! Hallmac has engineered and built pipelines under all climates, conditions and circumstances — on schedule! When you talk pipelines, talk to J. W. (Bill) Hall, President, Hallmac Construction Company. 3701 Buffalo Drive, Houston 19, Texas

Contractors

● **Morrison-Shivers, Ltd., Box 1076, Austin, Texas.** Has 48 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Nipigon and Beardmore. Also has 62 miles of 30-in. for *Trans-Canada Pipe Lines* at North Bay, Ontario.

● **Engelking and James, Ltd., Edmonton, Alberta.** Has 88 miles of 14-in., 3.5 miles of 16-in. and a total of 23 miles of various other lines for *Saskatchewan Power Corporation* from and in Success and Hatton gas fields in Saskatchewan.

● **Latex Construction Company of Georgia, Box 12128, Atlanta 5, Georgia.** Has 58 miles of 8-in. for *South Carolina Natural Gas Company* from a point near Aiken to Hampton, South Carolina. Has contract for 14 miles of 18-in. and 16 miles of 12-in. loop lines near Petersburg and Richmond, Virginia, for *Commonwealth Natural Gas Company*. Has seven miles of 6-in. for *Standard Southern Corporation* between State docks and Hunter AFB in Savannah, Georgia. Also has contract for 12 miles of 4-in. on a recondition job for *Plantation Pipe Line Company*.

● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has contract on Spread Y, containing 91.3 miles of 30-in. gas line from Longlac to MP 584.8 at the east bank of the Shekak River for *Northern Ontario Pipe Line Crown Corporation*.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has approximately 28 miles of 30-in. concrete-coated pipe across Lake Borgne in St. Bernard Parish, Louisiana and Hancock County, Mississippi for *Tennessee Gas Transmission Company*. Has 38 miles of 30 and 24-in. for *Humble Oil & Refining Company*, about half of the company's Clear Lake to Port Arthur, Texas, natural gas line, extending from the Hankamer block valve to Port Arthur.

● **Mid-States Construction Company, P. O. Box 417, Mt. Vernon, Illinois.** Has 48 miles of ¾-in. to 8-in. line from Hematite to DeSoto, Missouri, for *Missouri Natural Gas Company*. Also has complete distribution system in city of DeSoto.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for take-up and reconditioning of 140 miles of 12-in. and 140 miles of 8-in. pipe from Teague to Huffman, Texas, for *Sinclair Pipe Line Company*.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Has 81 miles of 36-in. line for *Natural Gas Pipeline Company of America*, from a point west of Muscatine, Iowa, to the Princeton, Illinois, area. Has contract for 265 mile products pipeline for *Wabash Pipe Line Company* through Illinois from the Hartford-Wood River, Illinois, area to the Griffith, Indiana, area.

● **R. H. Fulton & Company, Box 1526, Lubbock, Texas.** Has 21 miles of 26-in. from Fritch, Texas, northward, and 205 miles of 36-in. to a point near Meade, Kansas, for *Natural Gas Pipeline Company of America*, and will also build segments of the line from Offerle to Lincoln, Kansas.

● **Harvey B. White Limited, Box 158, Windsor, Ontario.** Has undetermined amount of 4 to 8-in. distribution lines for *Consumers Gas Company* in cities of Pickering and Whitby, Ontario. Has undetermined amount of 2 to 6-in. distribution lines throughout Windsor, Ontario, for *Union Gas Company*.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Canadian News Notes . . .

Contract Let for Line From Swan Hills Area

Two contracts for construction of the 125 miles of 10 and 12-in. crude oil pipeline between the Swan Hills producing area of northern Alberta and the East Edmonton pipeline terminals have been awarded by Federated Pipe Lines, Ltd. The company is controlled by Home Oil Company, Ltd., and a large financial interest was recently taken by McColl-Frontenac Oil Company, Ltd., which owns a major part of the oil reserves in the Swan Hills area. It is understood that McColl is putting up a large part of the cost of the line, estimated at $6,500,000.

The northerly 40 miles, through very difficult muskeg terrain, will be laid by Mannix Company, Ltd., Calgary. The southerly 85 miles, which includes 6 miles of 12-in. line coming into Edmonton, is under contract to Fulton-Banister, Ltd., Edmonton. Construction is scheduled to start immediately, with completion projected for November 1. Pipe is all being supplied by Alberta Phoenix Tube and Pipe Ltd., Edmonton.

Because of a drop of 2000 ft in elevation between Swan Hills and Edmonton the line will operate by gravity flow up to 20,000 bbl per day throughput. It is expected to be at least two years before it carries this much oil. Ultimate capacity, with addition of pumping stations, will be 40,000 bbl per day.

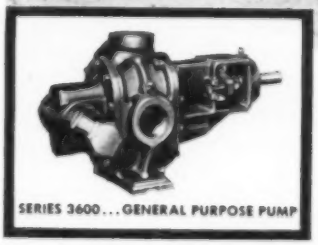
No terminal tankage will be built, as the line will deliver directly to both Trans Mountain and Interprovincial terminals in East Edmonton.

Interprovincial Defends Its Mode of Expansion

Interprovincial Pipe Line Company, which has nearly completed a looping program in western Canada as its major 1958 capital addition, stated to the Borden Royal Commission on Canada's energy resources that its system will be equivalent, after the present loop is in operation, to a single 30-in. line from Edmonton to Toronto. To replace the system with a new 30-in. line would cost $7,500,000 more than the total capital investment that has gone into it.

Designed to answer statements made by other submissions, to the effect that the Interprovincial line is not as efficient as a large line built in a single operation, the brief pointed out that the orderly stepwise program by which the original line has been expanded over an eight-year period has been the most economical method of meeting the gradual buildup of throughput demand. It provides a service, the company said, comparable to the lowest cost operating major pipelines in North America.

Covering the contentious question of a possible extension of oil markets to Montreal, Interprovincial said that in a year from the time when a decision might be reached by users to move oil from western Canada to Montreal, it could lay a 34-in. line from Sault Ste. Marie to Montreal and concurrently accelerate its planned western looping program, to deliver 200,000 bbl per day to Montreal, at a total cost of only $150,000,000. Promoters' estimates of the cost for a direct line to Montreal have varied from $350,000,000 to $450,000,000. For an extra $116,000,000 Interprovincial added, it could increase deliveries to Ontario refineries by 100,000 bbl per day.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Second Company Seeks Line from Benson Field

A second application has been filed in Saskatchewan for permission to lay a gathering system and a lateral in the Benson oilfield area, by Producers Pipe Line, Ltd., Regina. The original applicant was Gibson Petroleum Company, Ltd. Producers' project would include 6.77 miles of 4-in. laterals and 5.56 miles of 4-in. gathering lines. The lateral would connect with the existing gathering system of Producers in the Midale oil field to the southwest.

Carbon Field-Calgary Pipeline Is Underway

Canadian Western Natural Gas Company, Ltd. is using its own construction crew for a 58.8 mile 16-in. natural gas pipeline from the Carbon gas field to Calgary, to provide additional peak load gas for the city system. Work started early in July, as soon as the company received its official permit from the Alberta Department of Highways. A small field gathering system is also under construction. All work is due for completion early in September.

Alberta Gas' 1958 Program Completed Ahead of Schedule

The entire pipelaying job on the main line extensions and laterals of The Alberta Trunk Line Company, Ltd., was completed ahead of schedule before the end of July. The 1958 program, largest in the four-year plan set up last year, is expected to cost about $25,000,000, or nearly half the overall total of $52,000,000.

Exceptionally good footage was obtained on the dry terrain during the latter part of the job on the 144.5 miles of 24-in. line from Pincher Creek gas field to the main line junction at Princess. The spread of Piggott Construction Ltd., Calgary, under superintendent Fred Byers, made 14,000 ft, on one day with the pipe gang and 18,000 ft with the dope gang on another day. Average footage was over 10,000 ft, or almost two miles per day.

An unusual feature of the job was a large number of irrigation ditches, all of which had to be crossed either by cutting and backfilling, using a flume to divert the water, or by going under with a bored and cased crossing in the case of the larger ditches. Two sets of canals were crossed in the early spring before they were carrying water. Veteran foremen on the spread described the line in these congested areas as looking like spaghetti, chopped up fine. Four irrigation districts were involved, and the total number of ditches was calculated as about 110. Soil was excellent for ditching, however, and the entire ditch was cut with two rotary ditchers.

Large SPC Project Nearing Completion

The 1958 construction program of Saskatchewan Power Corporation, the largest natural gas pipeline schedule in its history, was almost completed at the end of July, with only some valve setting, meter stations, and a few small town distribution systems remaining to be finished. Approximately 471 miles of line were laid, including individual service lines for house connections in the cities and towns. The total mileage in operation will be increased to about 1145 miles. Exceptionally dry weather helped to keep all jobs ahead of schedule.

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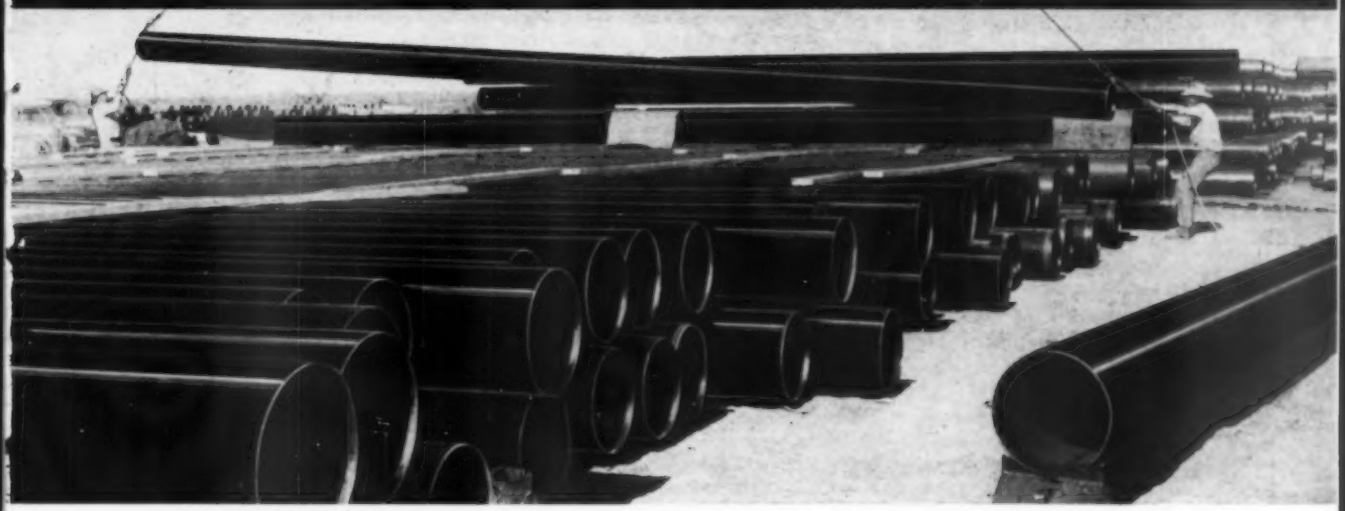

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Pipeline Projects

El Paso Natural Plans Salt Lake-California Line

El Paso Natural Gas Company announces it has entered into contracts to purchase 400,000,000 cu ft of gas a day over a period of 20 years to meet the rising needs of its California markets.

The contracts call for purchase of 200,000,000 cu ft of gas a day from Colorado Interstate Gas Company and of 200,000,000 cu ft a day from Pacific Northwest Pipeline Corporation, with delivery at Rock Springs, Wyoming. El Paso will deliver the gas to the Southern California Gas Company and the Southern Counties Gas Company of California at a point on the California border southwest of Las Vegas, Nevada.

Paul Kayser, El Paso president, said that a new 34-in. 400-mile pipeline will be built by El Paso Natural from the point on the California-Nevada border to a point south of Salt Lake City, Utah, and that Colorado Interstate will build a 140-mile line from there to Rock Springs, Wyoming.

The pipeline, which will have a capacity in excess of 700,000,000 cu ft a day, also will be capable of moving 150,000,000 cu ft a day from Alberta sources to the American market, Kayser said. Westcoast Transmission Company has pending applications before the Canadian government for authority to export this gas. The contract with Pacific Northwest provides for the delivery of this Canadian gas whenever its export is authorized by the Canadian government.

Construction of the pipeline, Kayser said, is a modification of a plan announced earlier by the company to build a line from Twin Falls, Idaho, to the California border southwest of Las Vegas.

Applications to the Federal Power Commission for the necessary authority to construct the pipeline are now being prepared by El Paso Natural Gas Company and Pacific Northwest Pipeline Corporation and will be promptly filed with the FPC.

The El Paso Natural Gas Company has entered into a sales contract with the Southern California Companies covering the 400,000,000 cu ft per day purchased from Pacific Northwest and Colorado Interstate, as well as the 150,000,000 cu ft a day from Canada.

Standard Is Planning Chicago Products Terminal

Standard Oil Company has taken an option on 40-acres northwest of O'Hare field at the junction of Touhy Avenue and Elmhurst Road, Chicago, as a site for construction of a new petroleum products distribution terminal.

Construction of the new terminal is expected to begin about the middle of September, according to Richard E. Nelson Jr., director of operations for Standard Oil's supply and transportation department.

Terminal operations will be conducted from a modern one-story air-conditioned office building. Facilities planned at the new terminal include storage tanks for gasoline, fuel oil, and jet fuels.

Products will reach the projected terminal by a new 33-mile pipeline, yet to be built. An 8-in. line is under construction. It will connect with an existing Standard Oil products pipeline that runs along the Chicago Sanitary and Ship Canal and services the company's main Chicago terminal at 4811 South Harlem Avenue.

The new facilities are expected to go into operation in mid-1959.

New Station Will Provide Increased Margin of Safety

Algonquin Gas Transmission Corporation has been authorized by the Federal Power Commission to construct and operate a 4000-hp compressor station at Cromwell, Connecticut, at an estimated cost of approximately $1,775,000.

The company's application said the compressor facilities will provide an increased margin of safety between its system requirements and system capacity. At present, Algonquin stated, this margin is 7,150,000 cu ft, or 3 percent of capacity, but with the additional facilities, the margin will be 34,563,000 cu ft.

Consumers Power Views Project Costing $13,200,000

Consumers Power Company has filed an application with the Michigan Public Service Commission asking approval of the proposed construction of gas pipelines and compressor station costing an estimated $17,600,000.

The proposed construction will enable Consumers to receive and distribute the large additional quantities of natural gas called for by its agreement with Trunkline Gas Company. This agreement provides that Trunkline shall deliver to Consumers 100,000,000 cu ft of gas a day beginning October 1, 1959, with deliveries increasing by 25,000,000 cu ft a day on October 1 of each of the four succeeding years.

Trunkline has applied to the Federal Power Commission for permission to build new pipeline and compressor facilities at a cost of $80,500,000 to carry out its end of the agreement.

Consumers proposes to build connecting pipeline facilities a distance of approximately 141 miles from the Indiana state line to interconnect with the company's facilities in Michigan. Estimated cost of the project is $13,200,000.

FPC Approves Project Michigan Gas Storage

Michigan Gas Storage Company has been authorized by the Federal Power Commission to lay 40 miles of 26-in. pipeline from a point in Gratiot County to Isabella County, Michigan, looping a part of its main transmission system. Additionally, 25 new wells will be drilled in Winterfield and Cranberry Lake storage fields, together with facilities to connect the wells to existing gathering systems.

The additional facilities are necessary to enable the company to meet increasing requirements of its sole customer, Consumers Power Company. Consumers' 1958-59 peak day requirements are estimated at about 523,500,000 cu ft. To meet these needs, Michigan Gas said it would have to withdraw 438,500,000 cu ft from storage to augment the 85,000,000 cu ft to be received on a peak day from its supplier, Panhandle Eastern Pipe Line Company. Present capacity of Michigan Gas' system is only 407,500,000 cu ft.

Shell to Extend Its West Texas Facilities

Shell Pipe Line Corporation announces plans for construction of a crude oil pipeline extending its facilities from Colorado City, Texas, to fields in the Borden-Garza County area of West Texas.

The project will consist of approximately 43 miles of 8-in. trunk line and about 20 miles of 4 and 6-in. gathering lines. A pump station and tankage will be located at the northwestern terminus of the trunk line, in Garza County. Completion scheduled for December 1.

Sinclair Builds Crude Oil Line As "Crash" Program

Because of Middle East conditions that pose a threat to the international oil supply, Sinclair Pipe Line Company adopted a "crash" construction program for its Wichita Falls-to-Jacksboro, Texas, crude oil line and expects it to be completed not later than September 15, perhaps sooner.

When the 60-mile, 12-in. carrier is completed, crude oil from West Texas and New Mexico can be diverted at Wichita Falls from usual northern destinations via the Basin Pipe Line System. The oil can be taken from the Basin System delivery point at Wichita Falls, routed through the new pipeline link to the input station at Jacksboro on Sinclair's recently completed North Texas to Houston "Big Inch" crude oil line, and delivered through to the Houston refining and port area for processing or transshipment.

Before the troubled Middle East situation, the line had been planned for construction in the indefinite future.

The new facility with one pumping station will have a throughput capacity of 43,000 bbl per day. The economic study of the project indicated a need in 1959 or 1960, but Sinclair management made the decision to construct immediately and stand in readiness in the event the Western Hemisphere pipeline is called on for emergency or "oil lift" service.

Texas Eastern Receives Final Permit for Station

The Federal Power Commission authorized Texas Eastern Transmission Corporation to constrct and operate a 6600-hp compressor station near Blessing, Matagorda County, Texas, at an estimated cost of about $2,388,400. The new station will be at the junction of Texas Eastern's existing 30-in. Vidor-McAllen and 24-in. Provident City-Blessing lines. FPC granted Texas Eastern temporary authorization for the station in February.

Ohio Fuel to Convert Medina Field to Storage

The Federal Power Commission has issued a certificate to The Ohio Fuel Oil Gas Company for construction and operation of facilities necessary to convert the company's depleted Medina gas producing field in Medina County, Ohio, into an underground natural storage area.

Ohio Fuel's project includes initially a 3300-hp compressor station and a gas injection and withdrawal system consisting of 12.4 miles of pipe ranging from 4 to 20 in. in diam. The company plans ultimately to drill 72 additional wells and build the necessary well lines for full development of the field.

Ultimate storage capacity is estimated at 8.5 billion cu ft of gas, with 7.7 billion cu ft proposed to be injected by November 1, 1961. This would provide an active storage volume of 3.4 billion cu ft over the proposed 4.3 billion cu ft of cushion gas.

Estimated total investment in the Medina pool is $5,075,504, including cushion gas. This amount would be spent over a three-year perior and includes an initial expenditure of $2,171,400 for the compressor station, pipelines, and metering facilities.

Jayhawk Is Planning Extension of System

Jayhawk Pipeline Company, now completing its system from southwestern Kansas to Valley Center, near Wichita, has made tentative plans to extend its feeder lines into Haskell and Morton counties. The system now originates in Meade County.

The 6-in. feeder lines would add about 140 miles. A southern feeder would extend about 90 miles west to the Interstate field, Morton County. Another line would extend northwest to the Pleasant Prairie field, Haskell County.

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Projects

Pioneer Expanding Its Supply and Service Areas

Pioneer Natural Gas Company recently began construction of 62 miles of high-pressure 10-in. natural gas transmission line, 20 miles of smaller-size gathering lines, and a 4000-hp compressor station at a total cost of $4,500,000.

The line will run from near Pampa in Gray County, Texas, to connect with the company's main transmission system near Canyon in Randall County, Texas.

C. I. Wall, Pioneer's president, in outlining the project, said: "The new line will add more than 25,000,000 cu ft per day of new gas supply to the present transmission system and also will connect the cities of Pampa and Panhandle, Texas, to Pioneer's main transmission system. In addition to Pampa and Panhandle, the new line will add to the supply of natural gas for Amarillo and the entire West Texas area served by Pioneer. The addition of this new source of natural gas is in keeping with Pioneer's long-range planning to provide adequate supply of natural gas for its service area through either company-owned reserves or reserves controlled through long-term purchase contracts.

Although the immediate project provides an additional 25,000,000 cu ft per day, the company's long-range planning anticipates increasing the capacity of this particular project to more than 50,000,000 cu ft per day and the ultimate construction of a processing plant.

Iranian Oil Lets Contract For 208-Mile Products Line

National Iranian Oil Company has awarded a contract to Benson and Montin Construction Company of Oklahoma City, for extension of its products pipeline system. The contract calls for laying 208 miles of 6 and 8-in. line from Teheran, present terminus of the company's lines, to Resht. Capacity will be 4000 bbl per day.

Work is scheduled to start in September.

Temporary Authority Given Pacific Northwest

The Federal Power Commission has granted Pacific Northwest Pipeline Corporation temporary authorization to construct and operate about 51.3 miles of 30-in. pipeline, at an estimated cost of approximately $5,542,200, in Lincoln and Sublette counties, Wyoming.

The proposed line will loop the company's existing 16-in. Big Piney lateral line and enable Pacific Northwest to receive natural gas purchased from independent producers in the Big Piney and the Tip Top — Hogsback fields in Sublette and Lincoln counties.

FPC Passes Favorably On Two Gas Projects

The Federal Power Commission in separate actions has granted temporary authority to Northern Natural Gas Company and to Atlantic Seaboard Corporation for the construction of natural gas pipeline facilities estimated to cost a total of nearly $4,000,000. The two projects are not related.

Northern (G-13, 875) received a temporary certificate to construct a 2000-hp compressor station in its Redfield, Iowa, storage field, to enable it to inject natural gas into the underlying Mt. Simon formation for testing purposes. Construction cost is estimated at $1,866,000.

The Atlantic Seaboard project (G-15, 129), estimated to cost $2,092,900, includes about 17.7 miles of 26-in. pipeline paralleling sections of the company's existing system in West Virginia between the Seneca and Lost River compressor stations, and in Virginia extending easterly from the Lost River station. The additional line is designated to enable Seaboard to transport an additional 36,500,000 cu ft of gas per day.

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PIPELINE PERSONALS

Stuart F. Silloway, president of Pacific Northwest Pipeline Corporation, has resigned to take the presidency of Harriman Ripley & Company, investment bankers. Paul Kayser, chairman of the Pacific Northwest board of directors, has been elected president of the company.

H. M. Karr, assistant manager of Shell Oil Company's engineering department, has been appointed to the new post of manager in charge of technology for Shell Pipe Line Corporation in the firm's head offices at Houston. **H. L. Isham,** assistant chief engineer-field at the Wilmington refinery, will succeed Karr.

Ralph E. Mullin, president of Westpan Hydrocarbon Company, Corpus Christi, Texas, has been elected to the board of directors of Colorado Interstate Gas Company. Mullin also is president and director of the Lotus Oil Company, the Trojan Oil and Gas Company and also is vice president and director of the A. R. Jones Oil and Operating Company, all headquartered in Corpus Christi. He also is a director of the Kansas City Bank and Trust Company of Kansas City, Missouri.

Benjamin H. Cooksey Jr., of Clarksburg, West Virginia, has been promoted to the position of manager of the gas measurement section of the operating department of the Hope Natural Gas Company. He succeeds **Charles G. Moorhead,** who retired. He formerly was superintendent of gas measurement in charge of field operations.

B. H. Cooksey Jr.

J. F. Barth

J. F. "Jack" Barth has been appointed supervisor of the authorization department, Service Pipe Line Company. He was formerly assistant supervisor. In his new position he succeeds **J. C. Stirling,** who is taking early retirement.

Stephen D. Bechtel Jr., executive vice president of Bechtel Corporation of San Francisco, has been named a new member of the board of directors of Tennessee Gas Transmission Company.

S. D. Bechtel Jr.

Dr. D. E. Holcomb

Dr. Dysart E. Holcomb, president of Texas Western College since June 1955, has submitted his resignation to accept a position as director of research and development for El Paso Natural Gas Company. Dr. Holcomb will be in charge of all research and development for El Paso Natural Gas and El Paso Natural Gas Products Company, as well as their subsidiaries.

Ora E. Hunter, head of the oil accounting section of Service Pipe Line Company, has retired after 40 years service. He will be succeeded by **L. Leon Conine,** former assistant.

W. B. Read, former dispatching engineer in the Ohio Oil Company's oil movements department, has been named the new assistant department supervisor. **R. W. Palmer** becomes chief crude oil dispatcher, succeeding **R. W. Barnes,** who retired.

Glover H. Cary Jr. formerly industrial representative, has been appointed manager of industrial development, Texas Gas Transmission Corporation.

J. Theodore Wolfe, president of Baltimore Gas and Electric Company, and second vice president of the American Gas Association, has been nominated to serve as president of the association for a one-year term beginning in October. **Robert W. Otto,** chairman of Laclede Gas Company, automatically joins the board of directors when his term as AGA president expires.

Wister H. Ligon, president of Nashville Gas Company, was nominated for first vice president; **L. T. Potter,** president of Lone Star Gas Company, for second vice president, and **Vincent T. Miles,** treasurer of Long Island Lighting Company, was renominated for treasurer.

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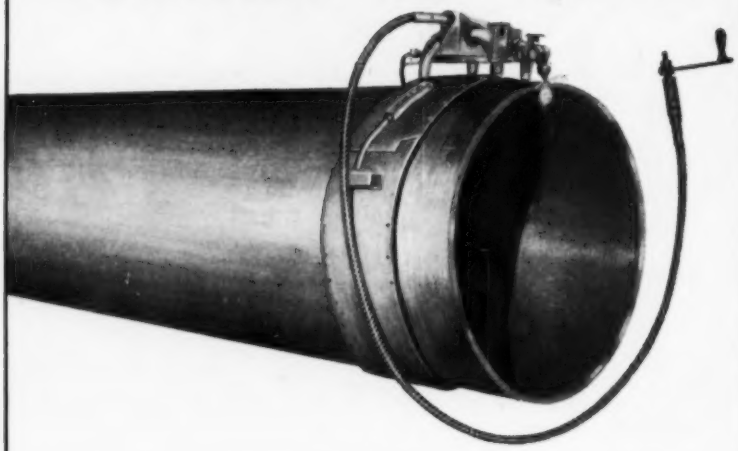

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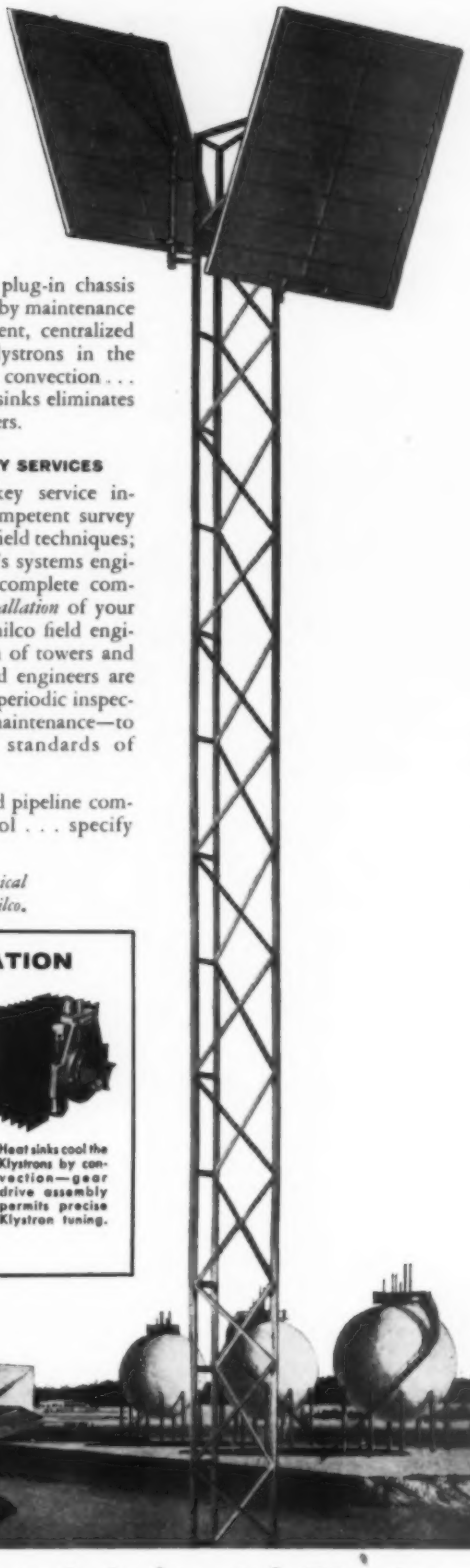

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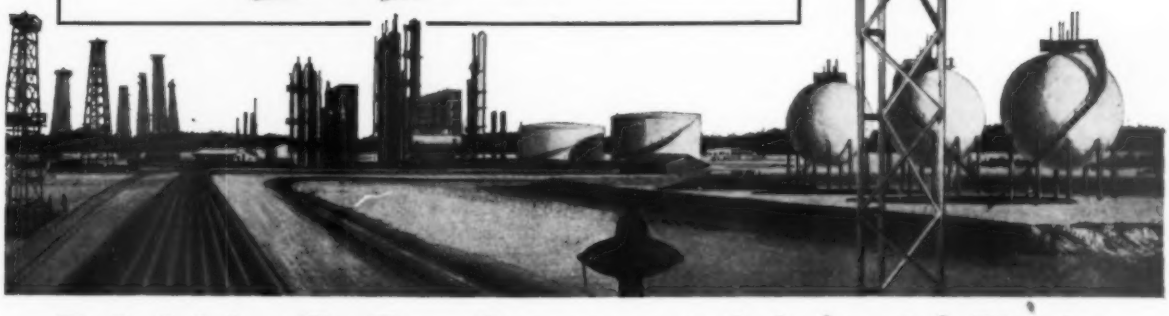
Rugged printed wiring panels increase circuit stability and simplify maintenance.

Heavy-duty, tubeless power supplies increase reliability by employing semiconductor rectifiers—assures maximum reliability and minimum maintenance.

Heat sinks cool the Klystrons by convection—gear drive assembly permits precise Klystron tuning.



PHILCO.

Government & Industrial Division

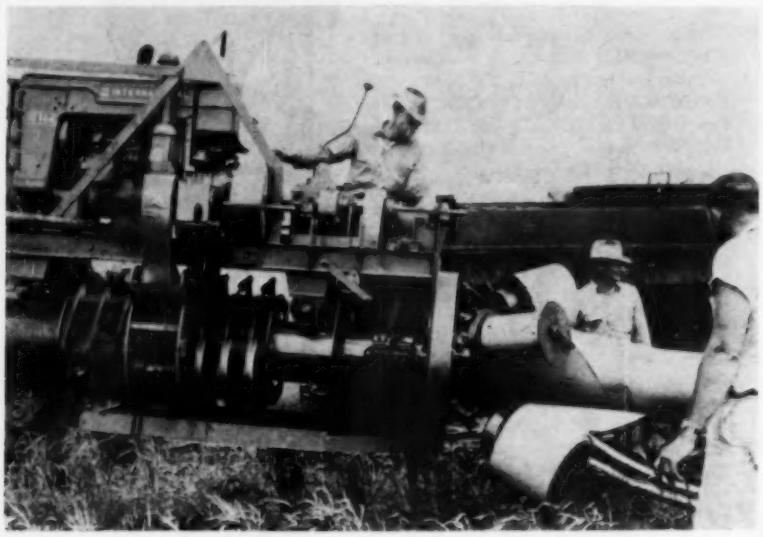
4718 Wissahickon Ave., Philadelphia 44, Pa.

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

It's New Pipeline Equipment

Cleaning, Coating and Wrapping Machine



Crutcher-Rolfs-Cummings, Inc., has introduced a line travel combination machine capable of cleaning, coating and wrapping pipelines simultaneously. The machine has been put to use on several pipeline jobs where a hot innercoat of microcrystalline wax, which requires no primer, was applied. The hot wax is sprayed and flooded directly onto the pipe immediately after the cleaning operation, and is then wrapped with a poly-vinylidene chlorid plastic wrapper. The pipe can be lowered directly into the ditch after it is cleaned, coated and wrapped.

The machine is manufactured in sizes to handle 3-in. pipe through 36-in. pipe, and larger if desired. *Crutcher-Rolfs-Cummings, Inc.*

Circle number (81) on reply card.

Natural Gas Line Dust Scrubber

A new type LD Hi-eF scrubber offers maintenance-free dust scrubbing of natural gas in pipelines. The unit can remove dust particles down to 10 microns in size and eliminates the use of filters or screens of any type to accomplish separation.

Dust elimination is achieved by controlling the flow of natural gas against an impingement baffle and through a purifier element that imparts to the stream an extremely rapid, centrifugal movement. This force draws dirt and other entrainment to the walls of the chamber where it is directed into a storage reservoir to be blown down periodically to atmosphere. *The V. D. Anderson Company.*

Circle number (82) on reply card.

Square-Root Integrator Totals Flow

Designed to meet instrumented system needs of flow measurement, a new square-root integrator provides a continuous means of automatically totaling flow. Designed for use in standard flowmeters that utilize the output of conventional sensing elements, the integrator can be adapted to miniature strip chart flow recorders, forming an electro-mechanical integrator.

Linearity of the square-root integrator is 0.25 percent of full scale, achieved with a repeatability of 0.05 percent of full scale. Operating temperature range of the instrument is —40 to +150 F. The pulse switch provides information to remote counters, telemetering or data handling system. *Librascope, Inc.*

Circle number (83) on reply card.

Forged Steel Couplings Added to Line

Koppers Company, Inc., has announced availability of a newly-designed forged steel coupling, produced in sizes No. 5½ and No. 6, which are both stronger and lighter than cast steel couplings used in most of the same applications. The 2 new sizes have been added to the Fast's forged steel line. Previously, this type had been available only in sizes No. 1½ to No. 5.

The center flange of all Koppers standard forged steel couplings are now nonrabbetted and are also interchangeable with the cast steel type in the new sizes. Both halves of each coupling are identical, and maintenance is simplified by the addition of 2 lubrication plugs. *Metal Products Division, Koppers Company, Inc.*

Circle number (84) on reply card.

Portable Pipeline Auger

A new self-powered portable pipeline auger featuring fingertip controlled hydraulic power has been produced by the Moorlane Company. The auger is designed to bore holes under streets, highways, and railroads, and is the only piece of equipment needed to bore holes for 2-in. through 10-in. size pipe.

A 7½-hp gasoline engine powers the auger and supplies power for a centrifugal water pump which forces water through the hollow auger sections. A unique device is a rotary hydraulic pump which develops up to 275 psi for a 2½-in. cylinder which feeds and retracts the auger drive, eliminating ratchet-lever or worm-screw feeds. *Moorlane Company.*

Circle number (85) on reply card.

Regulator Rating Increased

An increase from 1000 to 1500 psi in the maximum recommended inlet pressure of "141" regulators has been announced by Rockwell Manufacturing Company. The regulator is particularly useful along isolated gas transmission lines where industrial and domestic consumers requiring small volume service must tap the lines directly. The regulators are especially designed to handle primary cuts in pressure. The outlet pressure range is from 3 to 400 psi. *Rockwell Manufacturing Company.*

Circle number (86) on reply card.

Track Pin Press for Crawler Tractors

A track pin press, designed to press and replace track pins, remove and replace bushings, without removal of the track shoes, has been announced by the Owatonna Tool Company. The steel frame and ram assembly mounts on a steel base, but can be removed for transportation to the field for actual on-the-job-site repairs

or overhaul of track. A 35-ton 2-way single cylinder ram does the pushing with a full 7½-in. stroke which assures complete removal in one pushing cycle.

The press was originally designed for use on John Deere Model 40C and 420C, and J. I. Case Model 200, 300, 400, 500, or 600 crawler tractors. In addition, adaptor sets for practically all other similar size tractors are available. *Owatonna Tool Company.*

Circle number (87) on reply card.

New Equipment

Molded Casing Seal for Pipeline Crossings

The Maloney molded casing seal is the third of a series manufactured by the F. H. Maloney Company. The rubber compound has been formulated to withstand

abrasion from backfill during construction, and severe aging in use. A double convolute in the bellows section of the seal allows ample room for eccentric installations as well as extreme longitudinal shift of the carrier within the casing. Triple-thick walls at shear and pressure points eliminate the need for special rock shielding of the seal. Ribbed inner surfaces and stainless steel banding insures an impervious seal with long life. The seal is in a full range of carrier-casing size combinations. *F. H. Maloney Co.*

Circle number (88) on reply card.

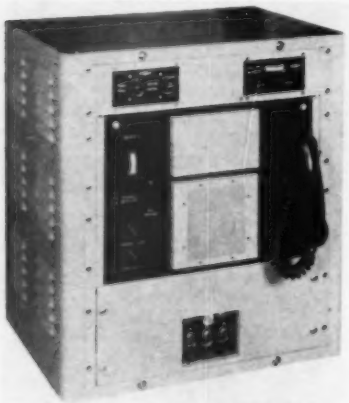
Upgrades 2-Way Radio Power

An add-on 250/330 w economy power package promises substantial savings to 2-way radio owners who need greater communications range. The package, to be known as the General Electric Power-Mate, is said to enable users of transmitters in the lower power ranges to upgrade their present systems to as high as 330 w at half the cost they normally would for a complete 330-w station. *General Electric Company.*

Circle number (89) on reply card.

Single Sideband Transceiver Announced

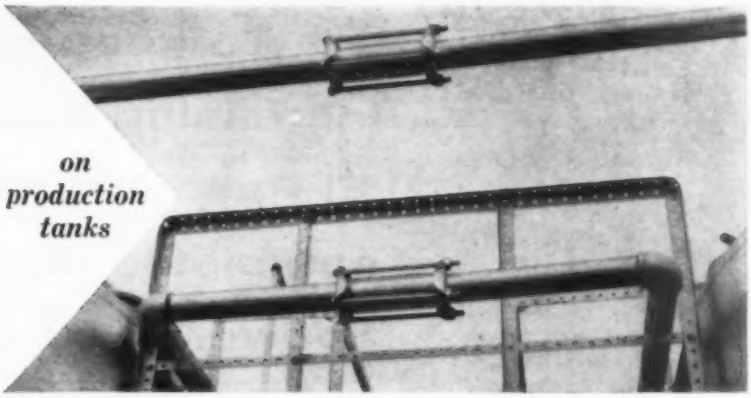
Collins Radio Company is marketing a new HF single sideband communication transceiver in 2 configurations: A cabinet version and a rack-mounted version. The



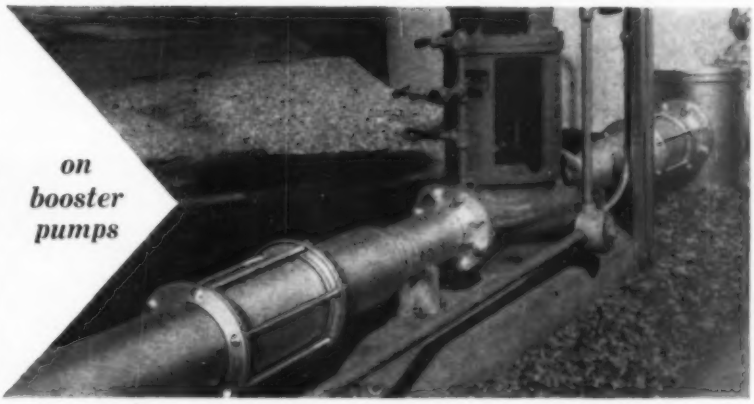
unit has an output of 100 w PEP on any one of 4 pretuned channels in the 1.6 to 12 megacycle frequency range. The transceiver features high stability, simplified controls for non-technical operators, voice actuation of transmitter function, automatic load control, and compact station packaging. Accessories available for the unit include directional wattmeter, phone patch, antenna coupler, and a number of antenna kits. *Collins Radio Company.*

Circle number (90) on reply card.

Dresser® Couplings—



simple, economical...



safe, permanent joints!

Dresser Couplings make safe, permanent joints with only a simple hand wrench in two man-minutes per bolt. This is a *part* of their economy . . . no specialized tools or labor. You save even more because the Dresser Coupling is used with plain end pipe. The specially compounded Dresser Gaskets allow up to 4° pipe deflection at every joint, saving delays caused by misaligned pipe. Take-down ease and re-usability are tremendous assets in moving pipe, and in adding new pumps, valves, or branch and connecting lines. Send for Dresser Catalog No. 531 . . . information and specifications on *all* Dresser Couplings, Fittings, and Pipe Repair Products.

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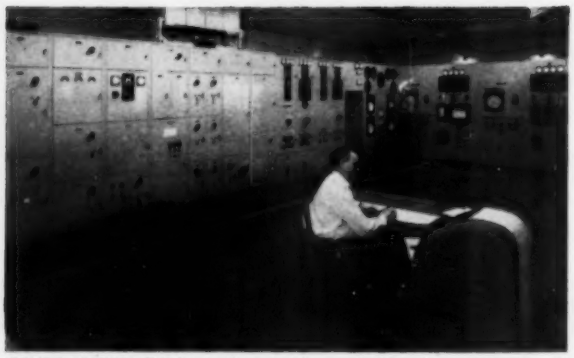
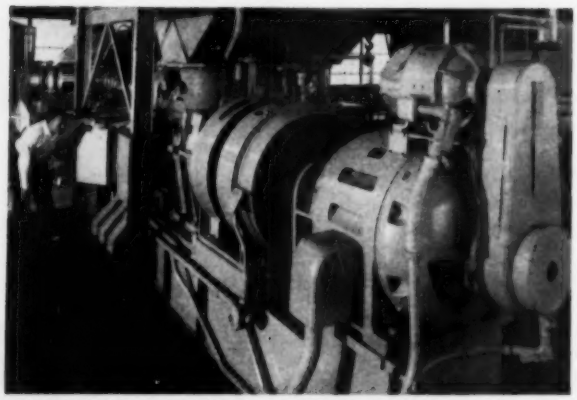
OPERATION upturn
Buy now for extra values
GENERAL ELECTRIC

To keep pace with their increasing customer demands, El Paso Natural Gas Company completes 11th pumping station powered by General Electric gas turbine drives

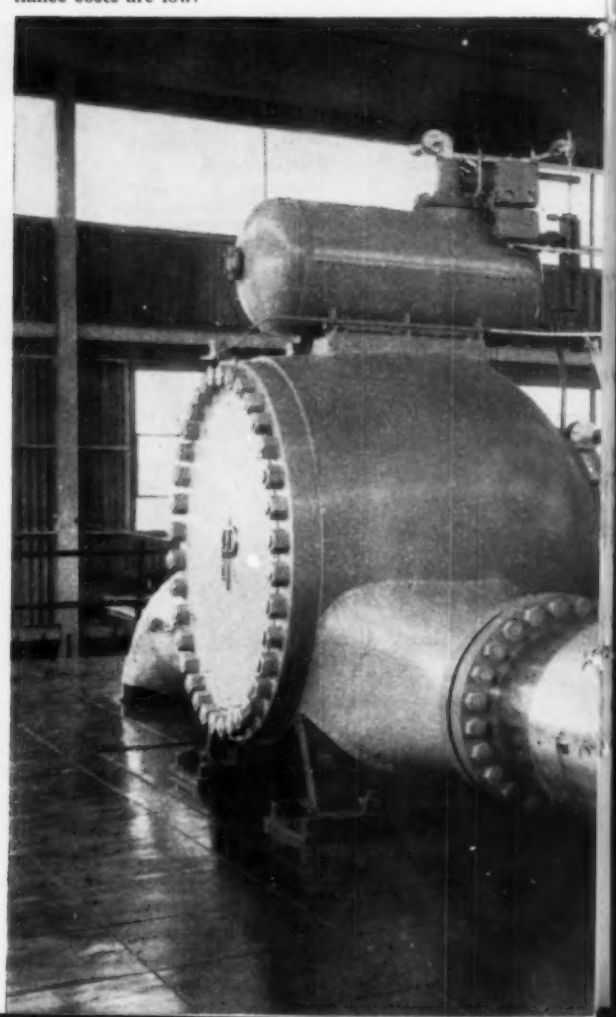
COMPACT GENERAL ELECTRIC GAS TURBINES can provide twice the horsepower of some other prime movers occupying the same floor space. This rotating gas turbine and centrifugal compressor provides smooth, quiet, operation. Installation and maintenance costs are low.



CENTRALIZED Cabinetrol control panels handle practically all auxiliary station functions from one convenient location. Centralized control saves operator time . . . cuts maintenance costs.



DEPENDABLE G-E Tri-Clad* AC Generator provides economical auxiliary power for Belen Station. Improved bearing system gives greater efficiency, longer life, reduced maintenance.



IN 1950, as a part of its continuing expansion program to meet growing demands for gas in the West, El Paso Natural Gas Company began the use of gas turbines for centrifugal compressor drives. The completion of Belen Turbine Station, near Belen, New Mexico, marks a recent step in the realization of their expansion plans.

Belen Station is the 11th EPNG facility to be equipped with General Electric gas turbine drives and centralized control systems. Performance records show that these rugged, compact G-E drives require very little maintenance, and afford substantial floor-space savings.

New, simplified General Electric turbine design eliminates the expense of maintaining a number of auxiliary pumps, blowers and associated equipment. Utilization of either full or semi-automatic control further reduces station operating costs.

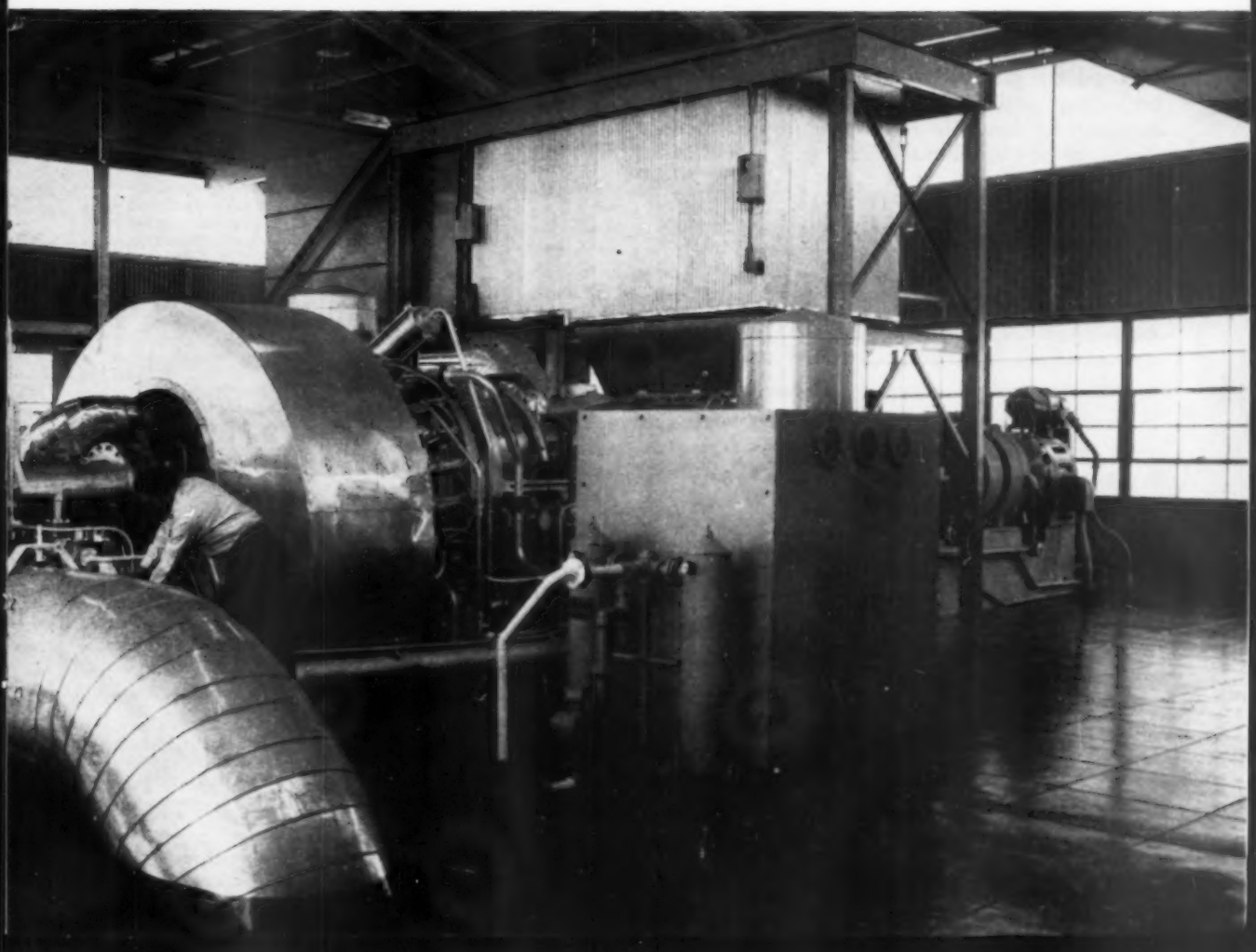
Pre-assembled G-E Cabinetrol* control panels help cut installation costs and centralize operation of auxiliary station functions. Because Cabinetrol control panels can be conveniently located in areas away from operating machinery, no expensive, specially protected equipment is necessary. In addition, the central location of control panels saves operator time and helps provide a neater station appearance.

General Electric offers complete engineering service to help you plan the drive system which best meets your gas-pipeline station requirements. Utilization of G-E's experienced system engineering staff can help you get your station in operation faster, with fewer problems, and with less expense. For complete information, contact your nearby General Electric Apparatus Sales Office. For full details on G-E gas turbines, write for free bulletin GED-3546, to General Electric Co., Section 662-51, Schenectady 5, N. Y.

* Reg. Trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC



AGAIN "Something New and Better..."

Stainless Steel Banding

Extra Strength

Double Convolute

Maloney

MOLDED PULL-ON CASING SEAL

The molded seal for **any job.** Double **accordion** design provides flexibility for eccentric installations, with plenty of room for longitudinal movement in **either** direction. Ribbed inner surfaces and stainless steel bands seal the rubber to the pipe to form an impervious joint. Maloney compounded rubber is extra thick at pressure and shear points eliminating the need for additional shielding. Long life, free from checking and other aging symptoms, is assured by production quality control of rubber compounding and molding. Installs with Stainless Steel banding for long life. Available immediately in the full range of size combinations.

Maloney

MODEL 58 FULL ENCIRCLEMENT CRADLE

The Cradle that supports the carrier **all the way around.** The Model 58 Centering Cradle is a double steel band with ribbed rubber lining to provide insulation and protect pipe wrap. Runners are steel and Neoprene, providing double insulation, **performance proven** in miles of crossings on the Model 55 Maloney insulators. Built-in tension in the cradle band holds it firmly in place during installation — without bolting. The Model 58 cradle is available in any combination of carrier-casing sizes to your specifications.

F.H. Maloney COMPANY

From the Irishman

HOUSTON, TEXAS

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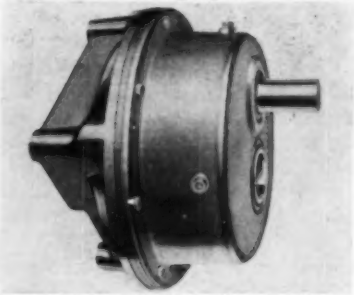
D-86

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New Equipment

Flange-Mounted Drive

Falk flange-mounted gear drive bolts directly to the driven machine. The unit is designed with bearing capacities for over-



hung and thrust loads to allow installation of drive into the driven machine as a geared pillow block, if desired. Thus it is possible to eliminate one machine bearing and cut down the overall size of the installation. *The Falk Corporation.*

Circle number (91) on reply card.

Pocket-Size 2-Way Radio

A new pocket-size, 2-way radio that transforms a man into a "walking radio station," is being demonstrated by RCA. The unit, which can be clipped to a belt or carried in a pocket, comprises a 10-ounce transistorized receiver and a 28-ounce transmitter, and has a range up to 2 miles in communication with mobile units or even longer with fixed stations.

The 2-way radio is a self-contained station operating in the 150 megacycle band. The fully-transistorized receiver measures only 6½ in. in its largest dimension. Power is supplied by a single small battery with a life of 150 hr. *Radio Corporation of America.*

Circle number (92) on reply card.

High Speed Remote Telepulse System

Shand and Jurs Company has announced its new high speed telepulse selective supervisory control system. Designed for precise remote reading of process variables such as liquid levels, tempera-

tures, pressures, etc., the 100 percent digital system also provides remote control of motors and valves.

Features of the system include liquid-level readings with ⅛-in. accuracy in 60-ft range, fully automatic selection confirmation and error checking, self-reporting alarms, indicating abnormal levels, temperatures, pressures, etc. The telepulse signal can be carried over poor-quality lines successfully and with no danger of message garbling or the equipment can be connected directly into standard telegraph and teletype circuits. *Shand and Jurs Company.*

Circle number (93) on reply card.

New Equipment

Welding Electrode Contains Iron Powder

Lincoln Electric Company has announced a new E-6012 electrode to reduce cost of general production and maintenance welding. Design of the electrode coating, which includes the addition of iron powder, makes the electrode easier to operate and faster than previous E-6012 designs. It is classed as an all-position, a-c and d-c, mild steel electrode. Inclusion of a moderate amount of iron powder and certain arc stabilizing ingredients to the coating produces an electrode said to combine the good bead appearance and a-c operation of an E-6013 electrode with the higher speeds and lower cost of an E-6012 electrode. *The Lincoln Electric Company.*

Circle number (94) on reply card.

Crane Lifts 45 Tons With 40-ft Boom

Capacity to lift 90,000 lb with a 40-ft boom, 11,000 lb more than its own working weight, is one of the important features of the new crawler mounted Koehring 545 "Sprawler." Pivoting outriggers, used when making heavy lifts, are swung into position and pedestals attached. The 545 can "walk" with 61,500 lb when the outriggers are not used. Stripped for transportation, the unit weighs only 47,500 lb. With the A-frame in a lowered position, the highest point with boom lowered is only 16 ft ¼ in. *Koehring Division.*

Circle number (95) on reply card.

Coal Tar-Epoxy Coating for Metal and Concrete

A new coal tar-epoxy coating designed to protect metals and concrete against severe corrosion conditions has been introduced by Cook Paint and Varnish Company. The coating is resistant to acids, alkalies, brine, petroleum products, hydrogen sulfide, and forms a tough film for service up to 400 F. The coating can be applied with brush, spray-gun, or paint roller and no primer is required. Two spray-gun passes are enough for one coat, with 2 such coats giving a 14-mil dry thickness. At normal temperatures (70 to 80 F), the coating may be recoated after overnight drying. *Cook Paint and Varnish Company.*

Circle number (96) on reply card.

Weather-Tight Floodlight

Appleton Electric's new 6050 Series, all-aluminum floodlights are designed to solve lighting in "problem" areas. The lights have an adjustable dial mechanism for wide range focus in any direction, allowing greater selection of beam spreads. A free-swinging cast-aluminum cover ring for quick lamp changing is also incorporated for simplicity and ease of servicing. *Appleton Electric Company.*

Circle number (97) on reply card.

Shopcoat for Couplings

Use of a new, durable, effective shopcoat, Dresser Red-"D," on its pipe couplings, is announced by Dresser Manufacturing Division. More than five years' research and development have gone into this shopcoat.

Dresser Red-"D" will give more than six months' protection against corrosion, a most important factor where couplings are kept in open storage at the job site months before use. *Dresser Manufacturing Division.*

Circle number (98) on reply card.

NEW LITERATURE

Power-Tilting and Power-Angling Dozers

Hydraulic power-tilting and power-angling dozers which are now available on Case TerraTrac 42 hp, Model 320 crawlers are described in Bulletin CTS-112. These new blades can be tilted or angled hydraulically while tractor is in motion. Tractor features, specifications and comparison charts are included in the bulletin. *J. I. Case Company.*

Circle number (99) on reply card.

Corrosion Resistant Valves Catalog

A new catalog has been published by W. G. Rovang and Associates, Inc. presenting its line of "Rovalves." The 22-page catalog describes and illustrates the company's 9 types of valves, listing features, material specifications, critical dimensions, and price lists for each type. The publication also includes ordering information and a discussion of Rovang's custom fabrication facilities. *W. G. Rovang and Associates, Inc.*

Circle number (100) on reply card.

Mobile Radio Guide

A 16-page booklet entitled "Under the Influence of Radio" is a guide for prospective users of mobile radio equipment. Included is information on licenses for base stations, mobile units, and for drivers. The booklet also contains instructions concerning adjustments, how to send a message and maintenance. *General Electric Communication Products Department.*

Circle number (101) on reply card.

Caterpillar D8 Improvements

Four years of product improvement to the Caterpillar D8 track-type tractor are illustrated and explained in a new brochure. The two color brochure is a handy reference guide to the engineering improvements that have been made to the D8. Many of these, not really noticeable on the machine, are illustrated in detail in the brochure. A large cross section view of the machine is keyed to show the major improvements. *Caterpillar Tractor Company.*

Circle number (102) on reply card.

THE NEW MINIATURIZED

WILKINSON Line Locator Model W-3

This radically new, powerful transistorized sub-surface locating instruments weighs only four pounds and is one-fourth the size of conventional pipe locators.

It's as handy as a flashlight; the transistors will rarely ever require replacing; non-leak mercury cells will last at least ten times longer. The maintenance is trivial. Molded glass fibre instrument cases insure maximum protection. The aluminum connecting handle telescopes to 17" and the entire instrument is packed in a substantial carrying case.

WILKINSON PRODUCTS COMPANY

3987 Chevy Chase Drive, PASADENA 3, CALIFORNIA. SYlvan 0-4314

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SEE YOUR NEAREST SUPPLY HOUSE

(Formerly: Pelican Well Tool & Supply Company)

New Literature

Steel Buildings In Color

Complete details on the recent development of the first pre-engineered steel buildings in color, using a new vinyl-aluminum protective coating, are contained in a new brochure entitled "Stran-Steel Buildings in Factory-Applied Stran-Satin Color."

A color guide in the brochure permits visualizing the design possibilities and color combinations that can be used on different types of buildings. The 6 metallic colors of blue, rose, green, bronze, white, and gray are shown. *Stran-Steel Corporation.*

Circle number (103) on reply card.

Plug-In Recorder Components

Product Specification E12-5 contains details of a new plug-in components for the Bailey recorder. Twelve types of receivers, controllers, retransmitters, and direct measuring devices from which the recorder may be custom-built, are described. Also illustrated is sealed, automatic, one-year inking system and many other exclusive features. *Bailey Meter Company.*

Circle number (104) on reply card.

Bulletin Describes Valve Regulators

The functions, applications and operation of Rockwell-Nordstrom valve regulators with Republic controls are described in a new illustrated bulletin issued by Rockwell Manufacturing Company. Valve regulators are pneumatically controlled, cylinder operated, lubricated plug valve regulators. They are designed to provide high pressure, large volume, gas regulation with minimum pressure loss.

Included in the bulletin are regulation capacity tables for the complete line of regulators, from 6 through 16 in. *Rockwell Manufacturing Company.*

Circle number (105) on reply card.

Full-Encirclement Saddle

Dimensional data, cyclic life and correct welding procedures for the Tube-Turn "Full-Encirclement Saddle" are detailed in a bulletin issued by Tube Turns. The saddle, widely used where "hot taps" are frequently required provides a full 360 deg reinforcement of the pipe and is split longitudinally. The bulletin includes a chart of relative life of branch connections, showing cyclic life of the saddle 11 times greater than ordinary saddles. Full-encirclement saddles are available for use with nominal pipe sizes 6 through 36 in. *Tube Turns.*

Circle number (106) on reply card.

Magnetic Flowmeter

A new technical bulletin issued by Fischer & Porter Company describes the company's obstructionless magnetic flowmeter which utilizes the principle of electromagnetic induction to produce an a-c signal which is directly proportional to flow rate. The brochure outlines the characteristics of the flowmeter, including construction materials, design features, operational limits, and capacity charts. A complete wiring diagram of the unit is also presented. *Fischer & Porter Company.*

Circle number (107) on reply card.

Flame-Cutting Equipment

A complete line of Oxweld flame-cutting equipment is described and illustrated in a 6-page folder printed by Linde Company. Torches that can be used interchangeably with every fuel gas combination — oxy-acetylene, oxy-propane, and oxy-natural gas — are described. The folder covers manual and machine cutting equipment for use on every flame-cutting job from thinnest sheet metal to risers 10 ft thick. *Linde Company.*

Circle number (108) on reply card.

Digital Telemetering System

TM-16 Telemetering Systems is the title of the new Control Corporation catalog. It fully describes both electrical and mechanical counters and information storage units, the scanner-transmitter, and the receiver and digital readout units. The brochure describes the complete operation cycle of the system and illustrates typical applications. *Control Corporation.*

Circle number (109) on reply card.

Semi-Automatic Welder

A new illustrated 2-page brochure describing the Colmonoy semi-automatic welder is available from Wall Colmonoy Corporation. The brochure points out and illustrates major construction features of the welder and lists a wide variety of typical applications. Tube wires available for use with the unit are also described in the literature. *Wall Colmonoy Corporation.*

Circle number (110) on reply card.

Spy Detector

QUALITY SERVICE

is there . . . when you need it!

. . . our SPY HOLIDAY DETECTORS are as near as your telephone— in fact, in emergencies our own plane assures immediate service.

MODEL 400

MODEL 200

Rugged equipment for dependable holiday detection on ¾" to 36" pipe . . . signal—bell, light and spark . . . unaffected by dew or frost.

Call, wire or write.

Pipeline Inspection Co., Inc.

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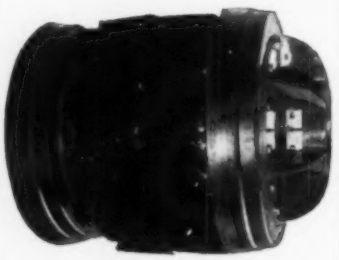
MOLE

Pipeline

Cleaner



for BETTER cleaning of

CRUDE LINES

PRODUCT LINES

NATURAL GAS LINES

FOR DETAILS WRITE

Pipeline Cleaners Co.

Fort Madison, Iowa

New Literature

Valve Catalog

The Ohio Injector Company has published a new condensed version of its general catalog, which lists its complete line of industrial valves. Valve figure numbers indexed for finger-tip reference by topics; face to face dimensions are supplied in full size ranges. Supplementary information is contained in a valve comparison chart, which offers a quick cross reference to the most commonly used figure numbers of ten valve manufacturers. *Ohio Injector Co.*

Circle number (111) on reply card.

Filter Service Tips

Helpful service tips on filter replacement are given in "Not An Element of Doubt," a new 8-page booklet. Filtering improvements developed by Caterpillar are explained in detail. The two-color booklet contains cost study information coupled with recommendations for extending oil change periods. The importance of proper fit, temperature stability, and rate of oil flow are discussed. *Caterpillar Tractor.*

Circle number (112) on reply card.

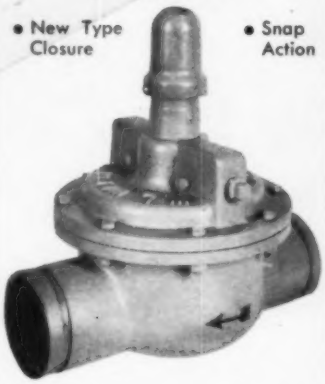
Gas Turbine Data

High efficiency, versatility, and low maintenance are important factors contributing to the commercial performance of Clark gas turbines. These flexible prime movers can meet a variety of power requirements in a wide range of applications, by providing mechanical drive, exhaust heat, steam or combustion air for use in processing. Two new catalogs describing latest developments in gas turbine design are available. *Clark Bros. Co.*

Circle number (113) on reply card.

Got Problems with AIR?

• New Type Closure • Snap Action



• Balanced Piston with O-Ring Seal
• Grooved Ends • Easy Installation

Get New WALKER AUTOMATIC SHUT-OFF VALVE

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Phone: Diamond 3-8241
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PIPE LEAK REPAIR — QUICK, FINAL!

ANY PRESSURE—ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

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LONE STAR

IS EQUIPPED TO HANDLE

★ ANY SIZE PIPE PROJECT
★ CROSS COUNTRY PIPE LINE CONSTRUCTION
★ PIPE LINE RIVER CROSSINGS
★ TAKING UP AND RECONDITIONING OLD PIPE LINES

LONE STAR PIPE LINE CONSTRUCTORS, INC.

Paul R. Halbert N. K. McFarland

OFFICE AND WAREHOUSE
10301 SHADY TRAIL
DALLAS 20, TEXAS PHONE FL 7-2833

Write for Bulletin

PIPELINE VENTS AND MARKERS

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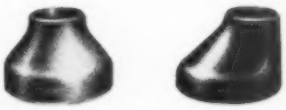
FLEET-LINE

WELDING FITTINGS

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.



SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

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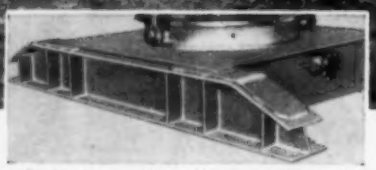
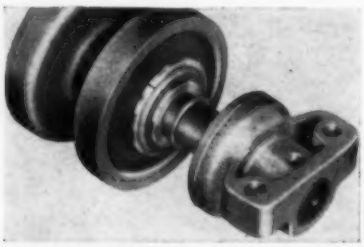


Carbody . . . wide and heavy to withstand stress. Three-piece removable bottom cover plate. Hinged center panel.

Crawler End Tumblers equipped with bronze seal rings.

Swing and Travel Shafts . . . large diameter with involute splining for greater reserve strength.



Crawler Rollers protected by bronze seal rings and by neoprene rubber O-rings.

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